

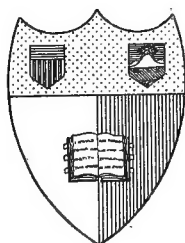
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The American System of
FLAX AND OTHER FIBER
CULTURE



By
DR. A. W. THORNTON

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European System
of Flax Culture Americanized
and
Adapted to ~~The~~ Local Conditions of U.S.A.
(Especially Puget Sound)

The American System
of Flax and Other
Fiber Culture

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Dr. A. W. Thornton
1917

By
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Flax for seed and fiber has been an established industry in Europe for several centuries, while in each section where the industry has been carried on, a different system has been practiced. Each system, varying to a greater, or less degree, but all more or less satisfactory in their results. The Irishman, adopting one system, being fully impressed with the idea, that his is the only correct one, and any departure therefrom is all wrong, and the result of gross ignorance. With due care, a good article is produced, and he fondly hugs himself with the delusive idea, that Irish flax is the best in the world. (?)

I go across to Belgium, in the district of Courtrai, I find an entirely and radically different system in use, and a better and higher priced quality of flax fibre produced there, Mister Irishman, to the contrary;—notwithstanding. My Belgian friend is just as fully convinced that the Irish system is all wrong. I leave Belgium and pass into Holland, and again find modifications in practice. Likewise, in Germany, Russia, Scandinavia and Austria, all practicing the peculiar system handed down from one generation to another as best adapted to their local conditions.

During recent years, however, the whole system of manipulating flax for fiber production is being modified to meet the requirements of modern manufacturers. Formerly the flax industry in Europe was chiefly conducted by the small peasant farmer, who grew the flax, retted, spun and wove it into domestic fabrics, and great was the pride evinced by the farmer's wife and daughters in the beautiful and artistic damask and linen fabrics which they produced. Now, however, that is all changed, and large spinning mills with thousands of spindles have been established, while the costly modern machines have been produced to cater to the increased requirements of the large spinners, they requiring large quantities of fibre, of uniform grades, while the small farmers could only produce small quantities of varying grades, the business passed into the hands of more extensive cultivators. Not only so, but the son cannot now work to advantage on the plan practiced by the father owing to new developments by the advance of agricultural science, in the way of fertilizers. The tactile skill of the father has not passed to the son. While the lessons taught the son in the Agricultural Colleges is an unknown language to the father. In the midst of this demoralization came the competition of the cheap cotton and shoddy goods and the peasant class with that want of foresight which characterises them as a class, were led to abandon the more durable, healthful and economical homespun products of the flax plant for the cheaper cotton.

Another strong competitor arose in the culture of the sugar beet, which, being a cash money crop, and not requiring the same amount of care, attention and hard work, helped to wean the small farmer from flax culture. So great was the falling off of the flax culture in Austria, that the Empress Theresa and Emperor Joseph 2nd, in order to stem the demoralizing tide and sustain this hand industry of the peasant established in Silicia, Bohemia, and Moravia, flourishing establishments which are carried on with

hand looms. Yet the competition of the English machines and hundreds of thousands of spindles, crippled the business and caused the hand looms and spinning wheels to be consigned to the garret, entirely destroying the "Amour propre" of the peasant wife in her handy work, causing a disregard for home industry, and an all-absorbing hunt after cheapness above every other consideration.

The peasant cannot now grow the quality of flax necessary to meet the requirements of the more perfect machines, which expose the minor defects unapparent under former conditions, so long as he continues to work in the old beaten track and therefore cannot compete with modern demands.

The Government assistance in Austria, to the encouragement of increased effort in flax culture, has not been exhausted by the work of Maria Theresa and Emperor Joseph 2nd, but in 1892, the Government appropriated funds and sent specialists to the flax growing regions to report on the system adopted in those countries; a synopsis of the information thus collected has been published for the instruction of agriculturists and others interested. Owing to the above conditions, the supply of the finer grades of flax fiber has greatly diminished, and the demand greatly exceeds the supply.

As many of the details of European practice are not now adapted to existing conditions in the U. S., it becomes necessary to elaborate a distinctively American system of flax culture and treatment, more especially adapted to Puget Sound, Western Oregon and Western Washington. A region so highly favored by nature, that it is the only region in our broad United States, where the highest grades of flax fibre can be produced, such grades as can successfully compete with the celebrated Courtrai flax of Belgium, which can only be produced in a very restricted region in Europe.

The necessity of modifying the system of flax manipulations adopted in Europe, became a question of flax or no flax on Puget Sound, if we would slavishly follow the old-time notions of European flax growers, the details of which are contrary to the spirit of the age and American progressiveness. Where would we procure American women to go into the flax field on their hands and knees, and weed flax with dragged skirts day after day or, American men with two or three pair of woolen stockings on their feet go and pick weeds? **THEY SIMPLY WOULD NOT DO IT AND THERE WOULD BE THE END OF FLAX CULTURE ON PUGET SOUND.** Whereas, by a distinctively American system, (Americanizing the European practice), cutting off useless corners and crossing lots we get there all the same.

Using labor-saving machinery and having our land clean of weeds **BEFORE SOWING** the flax seed, as herein set forth, we can establish a profitable and far-reaching industry that will not only prevent our sending millions of dollars to Europe, but owing to our climatic conditions and special adaptability for producing the highest grades of fine flax, will enable us to compete with

the European growers in their own market, and draw more millions of dollars from thence.

I am well aware interested parties will cavil and fling invective because I fail to worship their great Goddess Dianah, as it would occupy more time than I can afford, I will not here enter into a controversy, I will only say that from a long and varied experience on the Pacific Coast and special experience in flax culture in the field, I am better qualified to appreciate the varied questions that complicate this subject.

It was only when I brought my inconoclastic energies into play; not to Europeanize the American, but to Americanize the European practice, and establish a distinctively American system of flax culture and treatment and have formulated a practice adapted to the spirit of our people and the requirements of our region.

While we are all aware of this unholy and inexcusable war now devastating Europe, the question, "When the war is over, what then?" I noticed in one of our daily papers recently, "America, the World's Monte Christo," and my imagination, like that of Marconi, when he realized that unsurpassible vision of wireless telegraphy, gazed enraptured at the Utopian vision of the land where "the little roast pigs, with knife and fork sticking in their backs, ran about crying, "Come cut me up and eat me, come, cut me up and eat me!" While the war maddened flax growing nations of Europe were calling with canons roar, "Oh, America, come gobble up our cherished flax industry. Come quickly."(!)

The flax industry at this time on Puget Sound presents an ideal field for investment of capital, for several self-evident reasons:

First—This writer has already demonstrated as a fact that the soil and climatic conditions are adapted for the production of the highest grades of flax products, and during the time he was engaged as special agent, conducting important flax fiber investigations regarding the suitability of flax culture in the State of Washington, he had over sixty farmers cultivating flax under his direction on every quality of land in that state, with only two failures, one on raw turf and the other on very poor sandy land. All the others furnishing samples ranging from good to extra good. It may be of interest to mention that during the six years he was engaged in this investigation he thoroughly familiarized himself with all the details of manipulation with his own hands.

Second.—THE PROMPT AND PROFITABLE RETURNS UPON THE INVESTMENT.—Organizing a stock company at this time to exploit the industry would require first, a suitable site after contracts to be made with local farmers to cultivate and deliver flax straw, with the seed on, to the mill at a fixed price, would be in order, and the ordering of the seed from Europe for the first year's crop would be necessary. The second and subsequent we could grow our own PEDIGREE seed, which is even superior to European, this would be affected during the month

of December, in the first year, afterwards the contracts would be made in July and August, in subsequent years. This seed should arrive from Europe during February, in time to be segregated and delivered to the farmers to be sown under their contracts from the middle of March to the middle of April, according to the weather conditions.

The flax would be ready for pulling in July and dried and delivered to the mill in August. In the meantime the necessary buildings, machinery and manufacturing plant would be got in readiness. Work of retting and scutching would start up in the middle of August and by THE MIDDLE OF SEPTEMBER, 15 TO 20 TONS OF FLAX FIBER, WORTH FROM \$5,000 to \$10,000 WOULD BE READY FOR SHIPMENT TO EUROPE, TO BE FOLLOWED EVERY MONTH BY SIMILAR SHIPMENTS OF FIBER, until the following August, when the season's supply of straw would be worked up and the sheds empty and ready to receive the next season's crop.

Cash returns could be received here from Belfast or other European markets in sixty days or less after each shipment.

Note here under this arrangement three-fourths of the material on hand in August would be worked up and sold and shipped before the assessor's visit in March.

Third—A READY MARKET.—The disastrous condition of the flax industry, owing to the European war, the market for the high grade fiber producible on Puget Sound, is open to gobble all the flax we can produce.

In this treatise I have aimed to adopt what seemed to me the best points in each system and combined them into one harmonious whole, which, if followed closely, will not fail to enable the prospective flax grower to produce good results. There are three classes, however, that this book is specially intended for, and to whom I trust it will prove instructive and interesting. First, the prospective flax grower, entirely ignorant of the subject, but is willing to follow the instructions here given. He need have no fear of failure, but be fully assured of success. Second, the man who has some knowledge of the subject, but has forgotten many details of the work and approaches the subject in a teachable spirit. These instructions will prove of benefit. Third, the flax grower who thinks he knows it all, a man at the very best, very hard to deal with, however, by keeping a tight rein on, to keep him from kicking over the traces, if growing flax under contract, may be made to benefit thereby. There is one other class into whose hands this book may come. The man who not only thinks he knows it all, but goes a step farther and thinks he knows just a little more than it all. For him I have no use. He can gang his own gate!

The subject of co-operative flax culture is one of much interest and calls for some marks in this place. By co-operation I mean the farmer not only growing the flax for the scutcher, but also turning in his straw on joint account to be worked up by the scutcher in a manner somewhat similar to our furnishing milk

to the creamery. In Europe this plan is greatly approved but it must be remembered that in European flax regions the flax growers are well acquainted with all the details of the subject, it being an old established industry. While in the U. S. it is an infant industry and at first might become a source of a general kick.

Sound policy in this country, I think, suggests the practice, Let the grower grow the flax, let the scutcher scutch it, let the spinner spin it and the weaver weave it. Let the oil mill extract the oil and the lace maker make her dainty hand-spun lace. They are all distinct industries and should be operated independently. After the establishment of the flax industry on a sound basis and permanency has become an established fact, and the farmers educated up to it. Then it may be advantageous for a number of farmers to combine and erect a community scutch mill to work up their own flax and ship it to the open market upon joint account and divide the profits.

While there are hundreds of varieties of flax known to botanists, there is at this time only one in general use for fiber production, that is namely, SUMMER FLAX, LINUM USITATISSIMUM, of which, however, there are several sub-varieties, such as Riga, Dutch, Royal, White Flowered American. Among the different species of flax may be mentioned PERENNIAL, (Linum Perenne), still cultivated in the southern part of Europe with large blue flowers, but after many experiments it has failed to hold its place in competition with the summer flax as a fiber producer and its use has been abandoned. WINTER FLAX has also been largely tested and its use finally abandoned, as it had too great a tendency to branching and uncertainty in its growth. It was usually sown in August and matured in early summer. SUMMER FLAX (LINUM CREPETANS), this plant does not grow as tall as the ordinary Summer flax, (LINUM USITATISSIMUM), nor does it yield as much fiber. It has the bad habit of exploding the seed capsules suddenly when ripe and scattering its seed, and though producing more blossoms and seed, this is nullified by the great waste and loss of seed by its explosive habit.

SUMMER FLAX, (LINUM USITATISSIMUM), so called because of its extensive usefulness, is the species now altogether in use for fiber production, and has been endorsed by the International Flax Growers' Association in Vienna, in the following terms:

As learned from numerous experiments, we recommend culture of the blue flowering flax, (Linum Usitatissimum Vulgare), as the best. Of this species are several sub-species or varieties, which have become modified by the climate and soil on which they have been cultivated, such as Riga, Dutch, etc., and are adapted to different locations for planting. It must be remembered that many of the vast number of varieties of the bast fibers have a remarkable tendency to respond to varying local conditions, and one cannot predict before hand what vagaries the flax crop in different localities and under different management may

assume. The strawberry plant is a remarkable example of this peculiarity of this instability of individualism, owing to the source of supply. For instance, the Riga seed seems to take longer to ripen than the Dutch. While the Riga seed is better adapted for light or medium soils, and the Dutch to heavy soils, the Dutch also produces a finer fiber than the Riga. There is also a variety called "White Flowering Flax," which grows very tall with a white blossom; growing tall and fine in the straw, producing a large yield of good fiber and easily retted, and does well on Puget Sound, but the seed deteriorates rapidly and requires to be pedigreed by thick sowing and allowed to fully ripen. There is also a variety called "Royal Flax Seed," which grows very fine and tall on Puget Sound. Although it does not do so well in Europe. It is well to bear in mind the peculiar varieties of the different varieties of flax seed, that it is a matter of the greatest importance, that the seed that is the best adapted to local conditions should be used. Doubtless there is still room for much experiment and many considerable divergencies will be found from European experience and high rewards, and much fascinating enjoyment and pleasure from such horticultural investigations will be experienced.

Before entering into details, there are some fundamental principles that are at the base of the flax industry which should be thoroughly comprehended and constantly borne in mind and govern flax grower at all times in modifying any of these instructions as the intelligent farmer may require to meet his individual requirements.

FUNDAMENTAL PRINCIPLES

WEEDS ARE DEATH TO FLAX.—I repeat, weeds are death to flax, and once more I say, "WEEDS ARE DEATH TO FLAX." It is worse than useless to attempt to grow flax for fiber on weedy ground on Puget Sound or anywhere else. Care and neatness are necessary in tillage, harvesting and all subsequent processes. Careless culture will leave foul and cloddy ground upon which you cannot produce first quality flax. Careless tying of bundles will lower the price of the straw at the mill from \$1.00 to \$3.00 per ton, even though the quality of the flax is above the average in other respects. Why? The accompanying cuts will explain. In one case the mill will receive the bundle with satisfaction, in the other with the individual straws all tied up "higgldy-piggldy" up and down the bundle, the mill will require it to be opened and retied before it can be put into the brakes, and where the roots are all evenly placed they are all broken off at the first stroke, while in the other case it requires the bundle to be untied and retied at an extra expenditure of time, labor and cash, and the grower docked accordingly. Third.—Good seed and even sowing on a well prepared seed bed is absolutely indispensable for the reason that if the crop is patchy or uneven, from poor sowing and bad seed or cloddy seed bed, some of the flax grows thin and coarse in straw, while other portions grow thick in straw. As the finer straw takes a longer time

to ret than the coarse straw, only an uneven product is obtained. To modify this defect, it is necessary, either to make two or more sowing or pullings in separate lots at a greater expenditure of time, labor (and consequently of cost) and then dock the grower in price to recoup the extra cost. Fourth.—Do not plant more flax than you can safely handle at pulling time and have all necessary preparations made to harvest the crop.

Do not sow more seed than you can handle with safety at pulling time and have all necessary preparations made to harvest the crop just at the right time, otherwise you will have a crop of flax on hand WHICH MUST BE PULLED OR CUT, JUST AT THE RIGHT TIME OR BE SPOILED, and spoiled it will be as it soon deteriorates and very rapidly becomes over-ripe, to your very great pecuniary loss.

Fifth.—Be very careful in selection of seed for fiber produc-



Fiber Flax

Oil Flax

tion, as only the best of pedigree seeds (that is seed sown thickly and fully ripened in order to intensify the non-branching habit).

I here come to one of my fundamental principles which may be subject to controversy. The question at issue is simply in harvesting flax, pull the straw, or cut it with a harvester machine. This question first came up to me in my inexperienced days, and as is often the case, the less experts really know the more positive they were in asserting unsound opinions. One gentleman who had charge of a large flax mill in Minnesota, wrote to me that **FLAX COULD NOT BE CUT WITH SAFETY, BUT MUST BE PULLED**, and to add force to his opinion he said when flax was cut square off the ends would not enter easily into the machines. **IF HE HAD BEEN CONTENT** to drop the subject there, I might have been outwitted, but he graphically went on to say **THAT IN RETTING THE WATER WOULD SOAK INSIDE** of the hollow straw and cause an uneven ret.(!)

THE FACT BEING, THAT FLAX STRAW IS SOLID, AND NOT HOLLOW LIKE AN OATEN OR WHEATEN STRAW, and I allowed him to step down and out of the investigation as an unreliable witness. I therefore submitted the question to Mr. F. Barbour. He replied that so far from being injurious to cut the flax straw, he said it was a common practice, both in Ireland and in Belgium to cut the long flax straw into three lengths with a tool something like a circular saw, which they called "bottoms," "middles" and "tops," and use the "middles" for the finest work. With our improved harvesters and with our flax fields nicely leveled, and by having the knives kept very sharp we can cut our flax within one or two inches of the ground and practically no loss, but really at a saving of \$3.00 or \$4.00 per acre and upwards.

By careful attention to those fundamental principles, success in flax culture may be assured to the most inexperienced grower. It may be well in this place to give an epitome of the report of Messrs. Langer, Stanka and Lamach, who were sent in 1892 by the Austrian Government, to visit the several flax growing countries of Europe, and report on the present condition of flax culture and manufacture, from which may be learned the great difference of systems practiced in each. I do this the more readily because the report is hardly within reach of the American flax growers.

GERMANY (SAXONY.)

"It is a known fact that 1,000 years ago the flax industry was one of the most important and profitable in that country, but has since steadily decreased and passed from the hands of the peasant farmer to the hands of the large land holder. The competition of cotton and jute being responsible for this decline. In 1883 an appropriation by the state of Saxony: First—for establishing technical schools for flax culture. Second—to

supply a set of all the technical implements used in the Belgium method of flax culture. Third—to establish experimental farms suitable for flax culture. This appropriation lasted for seven years, when it passed into other hands of private parties. The government adopted the system of hot water retting as practiced by Watt, Schenk and the Americans.

SCUTCHING MILL IN MARIENBERG.

This mill is in the possession of H. C. Muller in Herschfeld, and may be called a model establishment. It is a one-story building with warehouse built on to it, also a retting house and scutch mill joined together with covered way passage. Behind the building is a large bleaching and drying green with wagon tracks to the retting warehouse, in retting house 12 cement tanks 3.6 metres, 4.5 metres long (177 inches), 1 1-4 metres deep, (49 inches), and have at the depth of 1 metre (36 inches) a perforated false bottom. The flax straw is tied in loose bundles of 21 inches, covered with straw at a temperature of 30 degrees Celcius. Each tank holds 5 metacentners of flax straw hauled to drying ground and opened and spread to dry and set up as shooks to dry according to the weather. The water from the tanks running irrigation ditches, runs into Carp ponds, as it is found to be absolutely uninjurious to fish. The working of the flax is done in the scutching house room where steam from the boilers is conducted to warm and dry the flax before going to the machine where it is put through the breaker. This breaker is made of 20 fluted rollers set in pairs, the first or those nearest the feed end are coarse and are gradually finer as the flax straw is drawn through. The flax is fed by putting the butts or root end of the straw to the rollers, which carries it through the series. The machine requires two attendants (one to feed and the other to carry off the broken straw). Twelve horsepower is required for the whole establishment. The scutching machine consists of 20 stocks, in sets of 10, each turning towards the other. These consist of cast iron wheels on which are fastened 8 knives of elm wood, projecting 2 or 3 inches beyond the periphery of the wheel. The broken flax is held through a slot in the scutching board and beaten by the knives on the scutching wheel which is made to revolve 170 to 180 times a minute. It requires practice in the operatives to do this work quickly and without any considerable loss of fiber. An ordinary days work of 11 hours for two men is 35 Kilos, (77 pounds), at 1 mark and 80 pfennings per day (25 cents). It is considered it costs 15 marks for preparing 50 kilos (110 pounds) of scutched flax. This establishment is not a profitable one. Owing to local conditions the hot water being found to produce an inferior grade of fiber, unsuited to the spinners requirements, and the hot water has been abandoned.

AT CHEMNITZ.

At Chemnitz they attempted to organize a co-operative union for flax culture. With the following rules: First—an interval of seven years between each crop of flax must intervene. Second—the previous crop must be fertilized with rye, wheat, oats, or one-year-old clover sod. Third—the flax field must be thoroughly drained and as free from weeds as possible. Fourth—the flax field must be plowed, sub-soiled and the surface leveled in the previous fall. Fifth—fresh manure and night soil is not permitted to be used, but a full dressing of 1000 kilos of kainit (2204 pounds) and 5.0 kilos (110 pounds) per hectare, (247 acres) of ground bone. Sixth—the seed to be sown as early in the spring as possible after the ground is made as smooth as possible by rolling and lightly harrowed. Seventh—4 1-2 centner of Russian, or 3 1-2 of rose flax seed. Eighth—it is absolutely necessary to remove weeds at the right time. The field must be weeded when the flax is six to eight centimeters high (2 or 3 inches). Ninth—the pulling of the straw is when it is more yellow than green and the greater part of the seed slightly brown. I give the foregoing account of work at Chemnitz as a sample of HOW NOT TO DO IT. (!)

PRUSSIAN SILESIA.

In Silesia, formerly the flax was more largely grown than in Saxony, while now it has gone greatly backward, being grown on a small scale in the uplands for domestic purposes, while the bottom lands have recently been more used for beets and rape. When grown for the market it is sold in the straw, or at best only retted, but not scutched. This falling off in production is owing to the competition of Russian flax, which, being of cheaper quality, is cheaper. In Popelau, the Prussian Government has established an experimental station for nine years past, illustrating the Belgian method of culture and management, and also small fields are established in the neighborhood as object lessons for the flax farmers and experts are sent to teach the farmers in the field the most improved system of work, while bulletins are published from time to time on the subject. The Prussian Government, in order to encourage the flax industry, use linen clothing for their army while other governments use the cheaper cotton fabrics. Professor R. Baur has been granted by the Prussian Government 16,000 marks to enable him to conduct experiments in new processes of flax treatment. Dr. Baur's invention was expected to produce a grade of flax to compete with that of Courtrai, but has failed to do so and is only adapted to the coarser fabrics and to hemp, nettles, chinqa and grasses, but the process is kept a secret. Enough is known, however, that Silesia cannot compete with Belgium in producing fine flax. Dr. Baur's improved method is a hot water, combined with acid and alkalies, is like all hot water and chemical systems while turning out a fiber of good color, they are all ill adapted to either wet or dry spinning.

BELGIUM.

From Antiquity east and especially west Flanders has been the home of flax culture of the finest grades where about 60,000 hectares (150,000 acres) are cultivated annually which represents 400,000 centners of fiber, worth 60,000,000 francs, giving employment to one-fifth of the population; three-fifths of the Belgian flax is exported, especially the higher grades. The Belgium spinneries spin only up to number 100 and 150. The Courtrai flaxes sell for 200 to 400 francs per kilo (18 to 36 cents per pound) and is chiefly used in the manufacture of the finest spinning in Ireland. The cause of the superiority of the quality of Belgian flax depends not only on the superiority of the soil but on all the conditions being especially favorable, as well as the great care exercised by the operators, while the limited area of product stimulates the prices and gives the producer a practical monopoly.

Cultivation.—The first principle in Belgian flax culture is rotation, spreading over seven or eight years, while subject to much variety the following may be given as a sample. Near Courtrai the following is a common rotation:

ROTATION OF CROPS (8 YEARS)

1. Flax, with clover sod subsoiled.
2. Clover.
3. Rye, with night soil.
4. Wheat.
5. Rape.
6. Potatoes, with night soil.
7. Oats.
8. Chicory, with night soil.

IN WEST FLANDERS.

1. Flax, with night soil.
2. Rye, with night soil.
3. Oats and clover.
4. Clover.
5. Wheat, with night soil.
6. Rye.
7. Potatoes.
8. Wheat, rye and barley.

Often beets are sown and recently beets have taken the place of flax in some parts of Belgium, which are always given good stable manure. (In the fall the fields are plowed, 25 to 30 centimetres (8 to 10 inches) deep, and the fields covered with night soil from the city. Large dressings of chemical fertilizers are used on sandy soil. The seed is sown in March and lightly harrowed and rolled, then weeded twice, pulling carefully at the end of June and beginning of July and is stacked up, allowing the seed to ripen and dry in the bolls after pulling, the fiber is not only preserved by drying but greatly improved. After a

week the flax is put into larger stacks to be rippled after harvest. After being rippled it is put in large stacks, carefully thatched and kept till the summer or fall of the next year, which greatly improves the fiber and renders the retting more uniform. The crop is usually 4,000 kilos to the hectare (8,816 pounds to 2½ acres). The crop of seed is variable, according to the season. A good season will yield 4,000 to 5,000 kilos (8,000 to 10,000 pounds).

RETTING.

Rettings, after the harvest, the work of the farmers is ended, as one or more contractors do the retting and the scutcher does his work, each keeping strictly to his own branch of the work, and thus becoming extremely expert and skilled in working flax to its finest grades, making a division of labor. Nowhere in Belgium is artificial retting used. The best flax comes from the name of Courtrai, as Lys retted flax, the retting is done in crates which are floated out in the river Lys and submerged. These crates are four metres long (about 12 feet long) 4 metres broad and 4 metres deep and hold the flax in bundles of 3 to 4 kilos (6 to 8 pounds), which is set upright. Double retting is now used all over Flanders, being so much better. The cost of double retting the straw is 34 to 36 francs per 1,000 kilos of straw, (\$20 per long ton).

SLIME RETTING IN EAST FLANDERS.

While the conditions for producing flax in this region are similar to the West Flanders and Courtrai regions, they have no river available for retting like the Lys and are to a great extent, dependent on slime retting, which consists of putting the straw in pits from which the ooze or slime has been removed, before the flax is put in. The best time for this is March or April. It consists in tying in small bundles and placing it on top of the water in a ditch where it sinks about half and is turned every day and left in the water one week and then taken out to dry in stocks and again given a second retting, this system occupying altogether from one to two months, and is used only under compulsion, but is somewhat better than dew retting, which system is only practiced where there are no water facilities.

SCUTCHING.

These scutch mills are usually of brick and have from 20 to 25 stocks placed in two rows. The brake contains 8 to 12 wheels. The cost of such a mill is about 1,000 francs. The waste from the brake is usually put through cylindrical shaking machines which frees the chive from the tow and which is pressed into bales of one cubic foot and sold as breaking tow, what comes from the uncleaned, sells for 20 to 25 centimes per 100 kilos, while cleaned for 200 francs per 100 kilos, while the scutched is sold for Courtrai flax at 200 to 400 dollars per long ton (equal to 19 to 36 cents per pound).

HOLLAND.

In Holland, except Friesland, not much flax is produced, owing to the land being of too heavy a quality to grow good flax. The slime retting is generally used but sometimes salt water is used which gives a very light colored flax, but small in yield and poor in quality. Friesland, where the land is light and the water soft they ret in pools. The flax is bound in bundles of 2 to 3 kilos and put in butt end down in the water and only immersed one-half, and after two or three days is turned several times a day. The whole straw is pushed under the water with boards and after being a week in the water it is taken out and after draining it is put in round stocks. This retting takes place in August and September. It must be remembered that only a small portion of it is retted in Holland, as the most of it is removed by the brokers to Courtrai and retted in the river Lys, and some to East Flanders and retted by the river process. The flax that is known in the market as Holland flax is dark colored, fine and lustrous, but is not thought so much of as the Courtrai.

IRELAND.

Ireland is the leading country for flax spinning, as there the finest grades of spinning is produced, and always lead in England and Europe. Ireland has imported in 1896, 19,697 tons of fiber; in 1891, 25,389 tons. This was chiefly Russian flax. The cutting up of large tracts of land into small farms has caused the discontinuance of flax culture in several districts. Also poor cultivation and disregard of the requirements of the flax plant has rendered the land flax sick. (Whisky, ignorance and carelessness renders the Irish farmer unfitted for flax culture. (The culture of the land is superficial and poorly conducted. Best farmers adopt a rotation of 7 to 12 years. Riga seed is used for light soil and Dutch seed for heavy land. They put the flax green and without rippling into the water. They pull the flax when green and ret immediately in ponds or ditches. (The Irish think more of the sperading of the flax after retting than retting itself.) The brewer has four pair of fluted rollers. Scutching arms are made of beechwood. The Irish scutcher is not so careful as the Belgian and does not scutch his flax clean. It is packed in bales of one stone (14 pounds). The yield of straw varies, the average being about two tons per acre, and the fiber of the best quality is 9 shillings per stone (14 pounds).

I have given the epitome of Professor Ludwig, Langreers' report because it is not available to the American reader and contains much valuable and interesting information and will now return to my subject proper. The formulation of my distinctively American system of flax and hemp culture and treatment. As I have given so much space to Germany, Belgium, Holland, Austria and Ireland, I must not overlook France, where much important work has been accomplished in the interest of fiber culture.

FRANCE FLAX BOUNTY LAWS.

By the law of January 13, 1892, to remain in force for six years, bounties for flax and hemp culture, according to the quantity grown of acres, will be granted for an amount not exceeding 500,000 francs. By a decree of April 13, 1892, bounties are granted only if the area entitled is at least 25 acres. By a decree of March 28, 1893, the number of acres to be tilled is reduced to 10.

The following bounties have been granted: In 1892, 132 francs per hectare (or say \$8.36 per acre). In 1893, 88 francs (or say \$5.75 per acre). In 1894, 72 francs per hectare (\$75 per acre). In 1895, 8 francs (equal to \$4.50 per acre). These bounties of the French Government are said to have greatly stimulated the flax culture in that country.

RUSSIA.

While more than two-thirds of all the flax produced in Europe is grown in Russia, yet the quality of the flax produced in that country is of a very low grade. There are in Russia two qualities of land used for the production of flax. One called the black land, where the flax is grown for seed, and the other called the red lands, where the flax is grown for fiber.

CANADA.

In Canada, also, large quantities of flax is grown. This is also of poor quality and low in price, being mostly dew retted. In the province of Ontario, one firm, Messrs. Livingstone Bros.' operate twelve scutch mills, and they are called the flax kings of Canada. Their flax having an average market value of 9 cents per pound in New York, the grower thus obtaining only about one and one-half ton of dry straw with the seed on per acre, and the straw yields eight per cent of fiber, while on Puget Sound I have obtained from 2½ to 4 tons of dry straw without the seed per acre, and the dry straw yielded 14 to 36 per cent of fiber of high quality.

THE LAND.

On Puget Sound and by parity of reasoning, my remarks will apply in a great measure to Western Washington and Western Oregon. I have found good crops of flax were produced on every quality of land with the exception of freshly broken peat and very dry sandy land, and even on that, with early sowing and irrigation, would have given satisfactory results. The good fruit and bench lands and alder uplands will probably produce the finest grade of fiber and our celebrated hop land will secure the heaviest crops of both flax and hemp. I have produced 4 tons of dry flax straw without seed on such land and the limit has by no means been reached, and I believe much larger crops could be produced on such land. Sandy loam, sandy clay loams, and strong clay loams are all well adapted to flax in this region.

While heavy clay, unless worked into the condition of a garden patch or onion bed (pretty difficult thing to accomplish) had better be avoided.

PREVIOUS CROP.

Having decided upon the quality of the land to be sown with flax it is of importance to consider its condition and previous crop. The most important factor at this point is to secure a clean seed-bed, as it is contrary to American ideas to spend time and labor in hand-weeding flax. We must secure clean land before we sow the flax. This requirement will be fairly met by sowing on a two-year-old clover sod that has been plowed deeply (10 to 12 inches) the previous fall and left to fallow all winter, then plowed shallow (2 to 3 inches) early as the weather conditions will permit, and run a light harrow two or three times over the surface before sowing. The object of this treatment is two-fold. First, to compel all weed seeds already in the soil to germinate and kill them by the consequent exposure to the weather and at the same time reducing the surface soil to a fine tilth. Deep rooting hoed crops, such as potatoes or carrots are good weed exterminators if kept all through the growing season constantly hoed **AND CLEAR OF WEEDS**. This system of culture is known as the intensive culture and dust mulch.

ROTATION OF CROPS.

As it used to be unprofitable to sow flax for two successive seasons on the same land without intervention of other crops, the European flax planters varying the interval from 5 to 12 years. It has been found advisable to introduce this system into my distinctively American system, varying indeed details in different localities, according to circumstances. Many farmers divide their available arable land into permanent fields of about one-tenth of whole area. Aim to have that quantity under flax each year, but always with the full interval between each crop of flax. If a farm of 40 acres be divided into five fields of 8 acres each, we will have the basis of a 5 year **ROTATION**.

ANOTHER FUNDAMENTAL PRINCIPLE.

As this phase of the subject is open to a confusing multitude of changes, I will confine myself to principles and what they call for. In another place I called attention to the law, **WEEDS ARE DEATH ON FLAX**. I am here met with the question: How do you eliminate the weeds by a simple and efficacious conformity with the fundamental requirements of the plan.

FLAX FOR OIL.

Flax for oil is produced by sowing the seed thinly (1 to 2 pecks per acre). This thin seeding has a tendency to induce a low stocky growth at the expense of the quality of the fiber for the production of which this oil producing seed can not be used without loss.

FIBER FLAX.

Fiber flax on the other hand required the land to be sown with the highest grade of pedigree seed in quantities of $2\frac{1}{2}$ bushels. This has the effect of a thick crowded crop being produced with no side branches and long, soft, strong fiber. This fiber flax is a dainty feeder, not like beet, corn or turnips and having only a delicate tap root that penetrates deeply and requires the nutriment it does absorb to be of the most assimilable qualities and the soil requires to be in the most permeable tilth for the tender root system to penetrate.

HEMP.

As this book was intended to elaborate my distinctly Americanized European system of fiber culture, hemp from its great value and high adaptability to our Puget Sound region, is entitled to a prominent place here. As fundamental principles, have a most important bearing on many of the phases of the fiber question, and right here we are met with some very interesting ones that require elaboration in this place.

There are several classes of commercial fibers, as the best fibers, such as Manilla, Agave, Aloe, etc., are produced in the thick, fleshy part of the leaves, and though possessing large industrial utility, are coarse in fiber and low in price, but not adapted to the requirements of Bast fibers. Among the Bast fibers we have first flax (which, owing to its superlative economical quality, the botanists named it *Linum Usitatissimum*).

Hemp is also of great economic importance. Then we have a number of less well known Bast fibers that yield strong, silky, beautiful fibers, but not yet admitted in general merchantable use. They are found among Mallows, Okra, Milkweed, the Nettles, Burdock, etc. In this place, however, returning to hemp which possesses some fundamental features that call for consideration, in contrast to flax. Flax, being a monaceous plant, that is one having the both male and female flowers on one plant. While the hemp has the male and the female flowers on different plants and is therefore called Diaceous, and here looms up another fundamental principle in which the flax matures whole plant at the same time when sowed broadcast. The hemp, on the contrary, grows its male plants about two or three times as high as the female plants and as soon as it sheds its pollen to fertilize the female plants it attains the highest state for producing the best fiber, while the female plant, continuing to mature its seed for three weeks or a month longer before it attains the stage of maturity to produce the highest quality of fiber. Consequently, when hemp is sown broadcast (as it is in Kentucky and other parts of the United States) and we cannot segregate the male from the female plants, they both grow together, the male plants being over-ripe and the female plants not sufficiently mature, both being materially depreciated in price and quality for want of uniformity.

My cure for this evil is simple and efficacious and its adoption will greatly enhance the pecuniary value of the finished product.

DR. A. W. THORTON'S SYSTEM OF HEMP CULTURE (IMPROVED)

In September or October plow 8 or 10 inches (if possible) with a jointer turning 3 inches of the surface growth to the bottom of the furrow and turning the balance of the furrow slice on top and you may leave the surface in that condition to mellow by the snow, frost and rain. If the season proves an open one it will increase the mellowing effect, to cultivate the surface not more than three inches. But this fall cultivation should not be attempted unless the soil is in good condition. As early in the spring as the condition of soil is suitable, plow only three inches deep, two or three times at intervals of a week, as this culture is for the purpose of starting the dormant weed seeds in the soil and exposing their tender root to wind and sunshine, you will have a mellow, clean seed-bed, and about the middle of April (if conditions are favorable) sow broadcast about 90 pounds of fresh, plump hemp seed with a light harrow about one or two inches deep. The hemp being a vigorous, umbrageous plant under such treatment, will smother all weeds.

There are usually only two systems of sowing hemp in the United States—drills and broadcast. Drilling has the disadvantage of allowing so much room to the root that the plants have a tendency to grow coarse and branchy to the great deterioration of the quality and price of the fiber. My system avoids that difficulty, but owing to the impossibility of segregating the male from the female seed, both are allowed to grow together to the utter destruction of uniformity in the quality of the fiber produced.

To secure my improved system is simple and efficacious and consists just prior to seeding to mark the hemp ground into plats six feet in width, lengthwise of the field, which can be easily accomplished with an ordinary garden marker.

Here it may be premised that the European practice was to leave 5 to 10 year intervals before sowing twice the same land with flax. The hemp plant may be sown for 20 years in succession, if the hemp leaves at pulling time are scattered on the same grounds it had grown upon. Having previously tested your hemp seed for its germinating quality, which by the way, is thus performed.

Select 100 average seeds of hemp and then spread them about one-fourth inch apart on a damp cloth in a saucer and place them in a warm place and cover them carefully, guarding the damp cloth from drying out, and cover with another piece of damp cloth or blotting paper will answer, and place the whole in a warm place. In a few days the good seed will swell and sprout. Count the seeds that have started, and if only 90 seeds have started it will be necessary to add 10 per cent; if only 80 seeds start, you will be required to add 20 per cent. If less than 75 seeds germinate it will be better to throw that lot of seed away or feed the canary bird with it.

Cover the seed with a light harrow and roll lightly if the

condition of the soil or weather requires it. The seeding may be done with a hand seeder, confining the seed to the alternate lands. Cahoon's hand seeder or the wheelbarrow broadcast sower are both good tools for this purpose. You will soon be able to distinguish male hemp plants from the female—the male plant growing three times taller than the female.

When the male plants have blossomed and shed most of their fertilizing pollen dust and their lower leaves begin to droop and turn yellow, they are ready to cut with a strong, sharp knife.

You will note here that you have marked off your hemp field into six feet wide lands, consequently you will have hemp growing only on the alternating plats and the others bare fallow. When the male plants are ready to harvest (remember sowing the seed in the first instance commence your sowing on the second) following the even numbered plats, 4, 6, 8 and so on, and leaving odd numbered fallow 1, 3, 5, etc., without seed. WHY? Because, when the male plants are in proper condition to yield their fiber in the best possible condition without injury to the female plants, it can be secured in the manner following: When the male plants have shed most of their pollen and the lower leaves are beginning to turn yellow and droop, drive your wagon along bare land (No. 1) and with a suitable sharp spud-like V-shaped tool cutting upwards with the bevel of edge on the upper side, place the sharp side of the V-shaped edge of the spud at the far side of the male hemp stalk, close to the ground, jerk it towards you with a quick action, when the hemp stalk will be cut off; with a quick action grasp the hemp stalk in one hand near the top, with the thumb up, and with the other hand strip all the leaves from top downwards and let them drop on the ground under the wagon as you progress. On this first trip on No. 1 you will cut all the male hemp stalks that grow three feet from edge of land No. 2. You will now have lot 1 with a lot of stripped foliage lying scattered on wagon track and land No. 2 with one-half the male hemp cut, and all the female hemp undisturbed, turning down bare lot No. 3 you will have No. 2 on one side with still half the male hemp stalks uncut, and on the other side of wagon lot No. 4 as yet untouched. On this trip (No. 3) you will cut male hemp on both sides of wagon and strip leaves as before, dropping them under wagon. When wagon is loaded with stripped stalks of male hemp they should be hauled convenient to retting tank until all male stalks are harvested and ready for retting. From this stage the female will continue their growth for about three weeks to mature their seed, when the seed reaches the dough stage, at which time the female plants will require to be cut and tied into stooks and set up to dry the seed.

Under this system of hemp culture you will observe male plants, if carefully handled, will yield their highest grade of fiber and first shipments will have been made and returns in transit and the crop of female hemp fiber and seed ready for manipula-

tion, and the foregoing will be found the only rational system to secure the highest returns for the full hemp crop.

The second year you would use the even numbered plats that were seeded this season as you would sow next season, and the odd numbered lots would be fallow. Should your land have been run down and not in the best condition you may with great advantage as soon as the female hemp is removed, plow as deeply as possible (8 or 10 inches) both odd and even numbered lots and sow crimson clover, harrow it lightly and allow the crimson clover to grow until the end of March, turning everything under, and proceed as the previous season. In mild climates the Southern Cow-Pea may be substituted for the crimson clover. The roots of both of those plants have the power of collecting nitrogen from the atmosphere and yielding up to the following growing plants. abundant supplies of that most valuable and costly of all our fertilizers. This system may be adopted with all our ordinary farm crops and quickly introduce the farmer adopting it to my Belgian friends, ideal of a flax farmer. "The flax farmer in my country is always the best farmer; the flax farmer in my country has always the best clothes, AND THE FLAX FARMER HAS ALWAYS SOME MONEY IN HIS POCKET!

Hemp is generally dew-retted in Europe and in the United States, but I do not recommend it, as much better results and higher prices are paid for water-retted hemp (threshed) until dry and fit for storage under cover properly ventilated, of course the seed will only be found on the female blossoms.

The female hemp plants should not be cut until the dough stage and is sufficiently solidified to withstand crushing in the rippling machines, and used for sowing in quantities of about 90 to 100 pounds per acre. Remember, a bushel of hemp used is only 44 pounds, sowing one inch deep.

UNCULTIVATED BAST FIBERS.

While flax and hemp are the chief commercial bast fibers, there are a vast number of valuable bast fibers that are now allowed to waste their usefulness in neglect, unhonored and unsung, this war, however, has attracted attention to the subject of providing substitutes and the Germans, with their well-developed preparedness, were not slow in turning their attention to those neglected sources of commercial remuneration and profit and have already established works to convert the common stinging nettle into a strong and high quality cloth for her army.

Among those basts, some grow in India, China, and others in hot climates, while some are indigenous to our favored region of Puget Sound and State of Washington and others are better adapted to the warmer states. However, I will select some of the most economically propagated.

First, then we have a most voluminous series of valuable bast fibers of which over 100 varieties are known to Botanists, scattered all over the world in tropical and sub-tropical, temperate and frigid regions, some fully adapted to conditions as they

exist on Puget Sound. Of American species, the Swamp Rose Mallow is perhaps the best known to the botanists under the name of "*Hibiscus Moscheutos*" inhabiting brackish marshes along the coast, extending up rivers far beyond the influence of salt water. The plant grows from four to eight feet in height and flowers late in summer. Experiments with this plant date back many years. Thirty years ago it was a subject to renewed experimentation in New Jersey, and placing its cultivation for fiber within the probabilities. In the second report of the bureau of Statistics, labor and industries in New Jersey, 1880, statements were made as follows:

"Recent experiments with Rose Mallow at Camden and Newark incline us strongly to believe that Jute (Jute here is a misnomer) as this section refers to "*Hibiscus*, the Indian Jute is a *Corchorus Clitterious*." One very great advantage the Rose Mallow has over "*Abutilon Avicennae*" with respect to economy of culture, consists in its being perennial. Like Ramie, the plants once established, the annual cutting from the stand would be a perpetual source of profit to the cultivator in case the quality and cost met our present expectations.

Forty years ago Rose Mallow roots were taken from the place of their natural growth and planted on the uplands on the Delaware river, with a view to utilization of fiber and for many years they held their own tenaciously as when growing in their own native swamps and they may be growing on those uplands today from all that is known to the contrary. Samples of fiber from the New Jersey experiments of thirty years ago were not only considered as good as Indian Jute but as secondary grades of imported hems.

THE ROSELLE HEMP PLANT.

This is the "Jamaica Indian Sorrell" (*Hibiscus Sabdariffa*) plant, which furnishes the "Rozelle" (or Oiselle hemp of the Madras territory.) In India it is small bush cultivated in many portions of that country, its stems yielding a strong silky fiber by retting the twigs when it flowers. The species grows in southern Florida where it is planted in March and comes to maturity in December.

A superb sample of this fiber was shown in the exhibit in Chicago in 1893, which was accompanied by the stalks some ten feet high as straight and clean as Jute stalks; the fiber is only produced experimentally in that country but it might be used commercially if the samples shown were average ones.

A FLORIDA SPECIES.

Another malvaceous plant grows wild all over India and is common in Florida, is "*Urena lobata*." Dr. Ernest, director of the National Museum, Caracas, Venezuela, describes the fiber as very fine, white in color and a metre in length (36 inches). It is very strong and takes dyes readily. Fiber of *Urena lobata* was received from Brazil, exhibition of 1876, where it is extracted readily and makes very strong fiber.

In the East Indies it has been used for the manufacture of paper. Spon says that a slip of sized paper weighing 39 grains made from this paper sustained 75 grs. against bank of England, note pulp 47 pounds. Mr. C. R. Dodge says: "I have found *Urena lobata*" growing in many parts of Florida, on east and west coasts, but I have never seen its slender stalks over three feet in height. It was several times pointed out to me as "Rammie" by people who had never seen the true Rammie growing. A common name which attaches to the plant in Florida is "Ceasar Weed."

SIDA FIBER.

Sida is another genus of malvacia plants found in both hemispheres, their bast being rich in fiber. A beautiful sample, *Sida Retusa*, known as Queensland Hemp, was received from Queensland in 1876, accompanied by another genus from Victoria, labeled "*Sida Rhombifolia*." The first was prepared by Dr. Guilfoyle, who states the plant has established itself in Melbourne, and is of very quick growth, seeding freely. He regards the fiber as suitable for fine paper and the manufacture of cordage.

The samples, *Rombifolia* is very white and lustrous, the filaments fine and even and the report accompanying it stated: "The bark yields an abundance of very delicate flax-like fiber which might advantageously be used for many purposes. The fiber is similar to Jute, but intrinsically so superior that it is worth from five dollars to six dollars per ton more and the sample is consequently placed beside that fiber in order to attract the attention it deserves.

COTTON STALK FIBER ("*Gossypium Haerbaceum*")

The cotton stalk is also one of the malvacia and it may not be known that it possesses a fiber of fine quality. In the latter of transmittal a strong case is made out in its favor, but it has two handicaps, the first, dependant on its adaptation to the hot climate renders it unsuited to our favored Puget Sound region, and the use of its chief product—cotton—renders its culture inimical to the production of the finer grades of fiber. Why? Because the advanced stage of maturity created in using its chief product (cotton and oil) reduces the quality for spinning purposes, so let it pass.

FOREIGN VARIETIES OF HIBISCUS.

So far we have been dealing with the Mallows, a large number of which come under the names of Hibiscus or hemp-like plants while possessing many commercially valuable properties, but their climatic habit renders them unfitted to our requirements. There are, however, of other bast fibers, quite a number available species, will pass on to another class known as the *Abutilon* species, many of which are indigenous in the State of Washington and well adapted to our requirements.

A very common variety has been cultivated experimentally in the United States, is the Indian Mallow ("Abutilon Avicenna"). It is an annual, growing to the height of 4, 6 and 8 feet stalks and more feet are recorded. It is widely distributed, north and south, east of the Rocky Mountains, and is found in the State of Washington.

The Indian Mallow grows so freely on any rich soil, even thrusting itself in and growing spontaneously that it has almost become a farm pest in many parts of the country. It grows luxuriantly throughout the west and north, producing even now vast quantities of fiber which rots on the stalk every year. The fiber is strong, glassy and white and the ligneous body of the plant yields more cellulose for paper stock than any other species. It has been claimed that fiber that has been extracted from plants that have not reached their maturity will be fine enough to work into yarn for carpet filling, and even fabrics can be so manufactured. It takes dyes readily, and an advantage in this respect is claimed over our Indian jute, which is antagonistic, to cheap bleaching and dyeing. The seed of the plant is so hardy that it is not affected by any climate.

Professor Waterhouse, at one time strongly advocated the cultivation of this species for its fiber, to which he gave the name "Bute," and at forty-five years of age he wrote as follows: "Abutilon Avicenna seems susceptible of development into a source of public wealth. The plant grows throughout the west in rank and wild luxuriance. It has the spirit and capacity of conquest. With invasive march it has taken possession of large tracts of land. Its tenacity of life and rapid spread renders its cultivation a far easier task than its extermination. There are today in the suburbs of St. Louis, stalks of Abutilon eight feet high. Unlike the Indian Jute, Abutilon needs no naturalization. To the manner born, it exhibits stubborn determination to occupy its heritage.

EXPERIMENTS WITH "ABUTILON AVICENNAE."

Experiments with the plant in cultivation date back fifty years at least, when it attracted considerable attention in the west, particularly in Illinois, through the endeavors of Mr. H. M. H. McConnell to establish the industry. The value of the fiber was demonstrated at that time by its manufacture into twine, rope etc., and in the report of a State Fair committee, in 1871, the fiber was given a flattering promise of utility.

According to this report the plants were stated to grow 9 to 14 feet high, the seed should be sown 12 to 16 quarts per acre. A volunteer crop will spring up the last of July which may be dew retted. The cost of cutting is given at 75 cents per acre. Water retting ten dollars, dew retting five dollars, hand cleaning, twelve dollars and half as much by machinery. Total cost, not including rent of land, \$19 to \$31. Messrs. McConnell offered \$100 per ton for all water retted that could be furnished and \$75 for dew retted. The crop is not exhaustive to the land if the refuse is returned to it.

Seven or eight years later the plant was subject of special investigation and experiment in the state of New Jersey, which resulted in very encouraging reports. There are also a number of species that are very valuable, a few of the best adapted to this country. I will here briefly refer to "*Abutilon Periplocifolium*," known commonly as "Maholtine," has been described as follows: It thrives magnificently in barren and rocky soil, the land is simply prepared by burning, when the seeds are thrown broadcast over the plain about the beginning of May, and the stalks are ready to be converted into fiber one year after. No attention is required to be paid to the plant while growing and wild weeds, etc., do not affect them in the least.

Plants growing very near to each other will produce very tall stems, say from 10 to 12 feet high and straight, but those that happen to grow far apart will shoot out branches and make bad growth, and the ribbons will be very irregular. I should say six inches from each other would give splendid growth. When the bark is green it can be peeled its entire length with no other preparation than steeping the stalks in pools of water for five to eight days.

The color of the fiber is a creamy yellow and some samples received measured 11 feet 10 inches in length. Samples submitted to London were favorably reported on and valued at \$85 to \$100 per ton. Among Brazilian species, "*A mollis*," "*A Bedfordianum*," and "*A Venosum*," all of which have been introduced into Australia, the last species especially has been experimented with in Victoria and according to Dr. Guilfoil, is capable of producing a fine quantity of fiber suitable for fishing lines, textile, fabrics and paper. A *Straitum* also is desirable, but I must here turn to another very interesting species of Bast fiber. Before leaving the "*Malvaceae*" I will refer to a few of that class known as "*Sida Refusa*," and a congener ("*S Rhombifolia*") the first is found to grow in both hemispheres, its bast being rich in fiber and is described as of very quick growth and seeding freely and is suitable for fine paper, and the manufacture of cordage. The other "*Rhombifolia*," Dr. Forbes pronounces as similar to Jute in appearance, but considered it intrinsical so superior that it was \$45 to \$46 per ton more. Experiments demonstrated the fact that a cord of one-half inch in circumference sustained a weight of 400 pounds. The fibers grow from four to five feet in length and displays a fine, soft and silky fiber. I think from various aspects of this question, the "*Sida*" offers great promise.

ASCLAPIAS (MILKWEED) FIBERS

The milkweed family, ("*Asclepiadaceae*") contains a large number of fiber-bearing plants found in various portions of the world, varying from shrubby growth a few feet in height, to the giant "*Asclapias*" of India, which reaches a height of ten feet or more. The several species in the United States all possess fibrous bark and bear seed pods filled with silky hairs resembling thistle down. Mr. C. R. Dodge, in his report on this sub-

ject says, "Of the points favorable to the culture of "Asclapias Incarnatas" are worth presenting here. It can be grown on overflowed land where no other cultivated plants will grow and yield double the fiber that flax will produce of which many thousand acres are available and the use of such lands would avoid drawing on our grain lands.

The crop is perennial and would not need renewing more than once in five years. The stalks stand well after maturity and can be harvested any time after October without injury to the fiber. The crop grows as far north as the 46th parallel. I incline to the opinion that cultivation will carry it up to the British line and perhaps beyond. It blossoms in August and the fiber does not fully develop till nearly quite ripe in September, for this reason a shortening of the season four weeks would injure its value. Undoubtedly "Asclapias Incarnata" promises better results than any of the indigenous species of bast fibers in the United States, that we have considered. If it will thrive upon waste land where no other crops will grow it has to that extent an advantage over hemp, considering the strength of its fiber as fully equal to hemp.

THE COMMON MILKWEED (OR SILKWEED)

("Asclapia Cornuti.")

Probably the commonest and best known milweed growing in the United States is the "Cornuti," found in Canada. While so widely distributed it does not seem to have been utilized for fiber beyond a limited experiment. The culture of the plant is said to be attended with little difficulty as it generally thrives on poor soil and like the former species, is a perennial one. It grows from either roots or seed and would be easily propagated and the only portion of the plant of which practical use can be made is the bast, which furnishes quite a fine, long, glossy fiber that is strong and durable.

THE STINGING NETTLE

("Urtica Gracilis")

The last of the bast fibers, I will here refer to are the stinging nettles as being specially adapted to our Puget Sound region, is a perennial and hardy and may be grown from roots or seed, has a fine, soft, strong and glossy fiber and other attractive features. The Germans are now producing it for the clothing of their army and find it very strong and serviceable. It possesses a fine, soft, white, silky fiber and of a finer ultimate fiber than flax and is especially adapted to combining with wool or animal fiber is of great strength and beauty. It is also admirably suited to converting into absorbent and aseptic dressing for surgical and hospital use.

ROTATION OF CROPS.

The subject of rotation of crops, is one of such great importance and yet a subject to innumerable variety of changes in detail, that I think it will be less confusing to confine my remarks to a few fundamental principles. Flax is a dainty feeder and

its root system consists of a delicate long tap root that penetrates the soil deeply, consequently, its plant food must be furnished in a most assimilable and nutritive condition, though not necessary in large quantity, but easily soluble in the soil moisture, therefore rank, lumpy, insoluble fertilizer are not adapted to the season it is sown on the previous crop. Consequently, a two-year-old clover and grass meadow may be dressed with well composted manure in the fall and plowed deeply, and thin strip of the surface plowed about three inches deep with a jointer plow and thrown to the bottom of the furrows and balance of the furrow slice eight or ten inches deep thrown over the surface slice of roots, manure and clover, and left exposed to the effect of frost and snow all winter. As soon as the weather and soil suits, toward the middle or end of March, plow shallow (not more than three or four inches). Why? This early and shallow working induces the weed seed to be started by the geniality of spring into germination and the exposure to the keen winds of March will kill them in the burning, then for three weeks run a light harrow over the surface until the middle or end of April and sow your flax seed and cover with brush, harrow, plank or light roller. The foregoing is the best plan of sowing. If for any cause, the foregoing is not practicable, you may plant a crop of potatoes after plowing the land deeply, keeping the crop well cultivated all summer. If the potatoes are an early variety you can dig them in September, seed a catch crop of Scarlet clover broadcast. This brings me to the subject of LEGUMES, known as nitrogen collectors, and have the curious property of forming nodules on the roots which absorbs nitrogen from the air if given a place in the rotation of crops, will take a prominent place in increasing the fertility of the land, so strongly is this property marked in LEGUMES in connection with flax, that one crop of clover returns more nitrogen than could be removed by two crops of flax. The following is a list of nearly all the LEGUMES, Peas, Beans, Clover, Vetches and all have the many varieties of fertilizing property in greater or lesser degree.

CULTURE.

In a pamphlet entitled, "Instructions for Flax in Ireland," by Michael Andrews, and published by the Flax Supply Association of Belfast, the following four year rotation is recommended:

1	Turnips	Potatoes
2	Wheat or Oats	Flax
3	Grass and Clover.	
4	Oats	
1	Potatoes	Turnips
2	Flax	Wheat or Oats
3	Clover and Grass	
4	Oats	
1	Turnips	Potatoes
2	Wheat or Oats	Flax

In this rotation flax never follows turnips, as in Ireland it is considered very objectionable. Again flax in the field only occurs every fourth year and by changing the location from one side of the field to the other, flax does not follow flax for nine years. It will also be observed that flax only occupies two-fifths of the field. Moreover, three out of four years the land is left bare in winter, and subject to leaching and washing out of the fertilizing ingredients from the soil by winter snow and rain. This is one of the objectionable features of European practice, our American system would substitute the following law, "Wherever possible, I would recommend LEGUMINOSE, planted in August or September, and is known by the name of a "Cover Crop," and remains all winter appropriating and storing up leaching fertilizers and permanently the stored-up fertilizers by deep plowing and covering with the balance of the furrow slice in the early spring, where it will be in an assimilable condition for the new roots that come within its reach.

SOIL AND SOIL EXHAUSTION.

Right here it may not be out of place to refer to a very generally held, though erroneous notion, that flax is very exhaustive on the soil, in this connection I cannot do better than quote from C. R. Dodge, report No. 10, on Flax Culture, in the United States, published by the U. S. Department of Agriculture, in which Mr. Eugene Boss, a leading authority on the subject, states as follows, "There is a strong prejudice among some people against the culture of flax, they say flax is hard on the land. I am painfully impressed in regard to the wisdom of those who advocate such an untrue thing, because of their ignorance of the composition of the plant, its habits and needs. Yes, the flax is hard on the land, when the farmer plows his land shallow, sows it thinly, and allows the weeds too much room to fill the space, THEN IT IS NOT THE FLAX THAT RUINS THE LAND, BUT THAT VERY RAPACIOUS ENEMY, *THE WEEDS*. PLOW THE LAND SHALLOW, AND YOU DO NOT LET THE PLANT FOLLOW ITS NATURAL COURSE. YOU FORCE ITS ROOTS TO FEED ON THE SURFACE, AND THERE LIES ONE OF THE REASONS WHY FLAX, AS COMMONLY CULTIVATED, REMAINS SHORT AND DRIES UP INSTEAD OF RIPENING NATURALLY. THE MOISTURE IT SO MUCH REQUIRES, IS TOO QUICKLY ABSORBED. IT IS TRUE I HAVE SEEN FIELDS OF PRETTY LONG FLAX THAT HAVE BEEN SOWN ON VERY SHALLOW LAND, BUT THAT LAND WAS VERY RICH OR VERY OPEN, WITH A PROPITIOUS SEASON. I DENY THAT FLAX IS HARDER ON LAND THAN WHEAT, RYE, OATS, OR BARLEY, WHEN SIMILARLY CULTIVATED, IT WANTS A DEEP SOIL TEN OR TWELVE INCHES AT LEAST. Thoroughly pulverized in order to allow its main root to go straight down

into the earth and find there most of the elements essential to healthy growth. A soil that is easily penetrated by the rain and permeated by the moisture of the air; such land must be rolled to keep it from drying and remain, as far as possible, a sort of reservoir for moisture. The land need not be very rich to raise good flax, when properly cultivated. As a recollection of past experience in Belgium proves, when a farmer in Belgium is too short of manure to raise winter wheat, he plows his land ten inches deep in the fall, the last part of April he plows it again six or seven inches deep, working it fine and about the fifth of May, on a bright, sunshiny morning, he sows two or two and one-half bushels of Riga or Belgium flax seed, harrows his seed twice crosswise on the seed, and the next day, if not wet, packs it well with a heavy roller. If he has a tolerably good season, he is sure to raise a fine crop of flax, and a good crop of winter wheat, without manure, the immediately following season. Was flax so hard a crop on land, assuredly such a result could not be obtained. Moreover, it is a fact well ascertained by science that flax draws its nourishment partly from the ground and partly from the atmosphere. Under such circumstances it naturally occurs to ask, why should flax have received such a bad reputation? This question has been very clearly answered in a recent report of Prof. Otto Luggier, of the Minnesota Agricultural Experiment Station, to Governor Wm. R. Merriam of that state, and published as Bulletin No. 13, December, 1890. As I understand that bulletin is now out of print, and the subject of such thrilling interest, and so high an example of expert skill of a scientific investigator, that I take the pleasure of giving it a place here. Mr. Luggier adopted three series of experiments to explain the cause of the failure of flax after flax on the same ground without an interval of rest. The first was on a piece of land seeded to flax for two years running. In 1888, a good crop of flax was produced and in 1889 every plant of flax had been killed. In 1890, twenty-four plots of this land were seeded to flax and various quantities of different fertilizers were applied to replace that removed by the previous crops of flax, while some test plots were left without fertilizer being applied. The seed all germinated in due time in all the plots, whether fertilized or not, and the ground covered with their beautiful foliage of green, but soon commenced to shrivel up and all disappeared before they were three inches high. This experiment indicated plainly that soil exhaustion by previous crops of flax was not the cause of failure, as all fertilizing material removed by the plant had been replaced in the land, in their most available form, the uniformity of the failure in all was very suggestive. A second series of experiments were made on the same ground to test whether this remarkable failure was from the development of any germ or microbe disease. Several plots were therefore treated with the most effectual germicides, in varying proportions, while some plots were left untreated, as test plots, the same result was obtained, the plants all dying when about three inches high in all the lots. During the continuance of these

experiments, microscopical examinations and dissections were constantly made, but no germs of disease, no microbes could be found. The young plants upon reaching the height of three inches and sometimes sooner, would simply wilt, turn black, and drop. It was therefore demonstrated that neither starvation of the soil nor the development of microbes was the cause of failure!

A third series of experiments was then undertaken to show that the old straw of flax was the cause of the trouble. In fact, the debris of the old crop acted as a poison to the succeeding flax crop. It has long been known in Europe that flax is a plant "unkind to its own relations." By "unkind" is meant that hitherto for some unknown reason, flax will not succeed flax. The reason, however, remained a mystery until Mr. Lugger made these experiments, demonstrating the real cause of this peculiarity. Sixteen plots of uniform size were selected upon good land, upon which flax had never been grown, these plots were arranged in a double row like a checkerboard, so that each plot treated by two plots not treated. The ground was well cultivated and seeded and between plots there was a path three feet wide.

Plot 1.—Was covered with sixty pounds of dry, healthy chaff of flax. This chaff was partly worked under the soil.

Plot 1.—(A) Contained nothing but seed.

Plot 2.—Was moistened with an extract made by soaking sixty pounds of old healthy flax chaff in cold water.

Plot 2.—(A) Contained nothing but seed.

Plot 3.—Was moistened with an extract made by soaking sixty pounds of old healthy flax chaff in boiling water.

Plot 3.—(A) Contained nothing but seed.

Plot 4.—Was moistened with an extract made by soaking one hundred and twenty pounds of healthy green flax in boiling water.

Plot 4.—(A) Contained nothing but seed.

Plot 5.—Was moistened with an extract made by soaking fifteen pounds of diseased fresh flax in boiling water.

Plot 5.—(A) Contained nothing but seed.

Plot 6.—Was moistened with an extract made by soaking fifteen pounds of diseased fresh flax in cold water.

Plot 6.—(A) Contained nothing but seed.

Plot 7.—Was covered with sixty pounds dry diseased chaff of flax. This chaff was partly worked under the soil.

Plot 7.—(A) Contained nothing but seed.

Plot 8.—Was covered with 120 pounds of green straw of flax, healthy plants of flax cut into small pieces.

Plot 8.—(A) Contained nothing but seed.

Owing to continuous dry weather the effect of these applications did not appear so soon as expected. The plants all commenced to grow until they had almost reached their full growth in size, when the disease made its appearance. The plots not treated with anything did not get any disease, only in some cases near the borders, where the winds had drifted some of the old chaff, but in all the plots treated the disease became manifest. The cold solutions had the least number of diseased plants. The hot solutions had caused the death of nearly one-half of all the plants. The dry chaff had killed all the plants and the plants were nearly denuded. As these experiments were carried on in a region infested with the disease, it was prudent to make similar ones in a region perfectly free from it. So two plots in a garden with rich soil was used by the experiment station, devoted to this purpose, the ground was thoroughly cultivated and seeded to flax as soon as the young plants appeared above the surface, the letters "M2" were staked out. After a strong, hot extract made and perfectly cooled it was applied with the spout of a sprinkling can along the lines of those letters. In this case when the disease did not appear until the plants had almost reached full size, but it did appear and killed every plant along the lines of the letters sprinkled with extract, plainly proving that we have not to deal with a disease, but that the straw of the flax is the cause of the trouble.

I give this lengthy notice of Mr. Lugger's important discovery as being distinctly American, it is entitled to a prominent place in an Americanized system of fiber culture and treatment, and to explode the old country notion, that flax is hard on the land. Also in part to show European readers, who think they know it all, or even a little more than it all, that it takes progressiveness of American character to exploit facts hidden for centuries.

While on the subject of work done at the Minnesota Experiment station, I cannot pass over Prof. H. Snyder, chemist of that station, who has carried on an exhaustive and elaborate series of chemical investigation on flax, in its chemical aspects. A report of which is published in Bulletin No. 47 for 1896 of that station, I will say here by way of parenthesis, that the Minnesota Experiment Station is rapidly taking "a front rank" for the work done there. Mr. Snyder, as a result of his investigations which brings the subject down to the latest dates, says, "In comparing the amount of fertility removed in the flax crop with that in other farm crops, it must be remembered that the figures given, represent the ease or difficulty with which the different food crops are capable of getting their food elements from the soil. The different farm crops have different feeding capacity as have different farm animals. Flax belongs to the dainty or weak feeding crops, it does not take a great deal of fertility from the soil, but the small amount it does take, must be in the very best and most available forms. Mangles and in fact nearly all farm crops are capable of taking their food in cruder forms and with far less difficulty than flax. A heavy crop of mangles will

remove five times as much potash, three times as much phosphoric acid, and nearly one and one-half more nitrogen than a crop of flax. A crop of corn removes a half more nitrogen, twice as much potash and about the same amount of phosphoric acid. While a good crop of oats removes practically the same amount of nitrogen and phosphoric acid and about three-fourths more potash than a crop of flax. Compared with wheat, flax removes less phosphoric acid and potash per acre and about half more nitrogen. Potatoes remove about the same quantity of phosphoric acid, one-third less nitrogen, three times more potash than an average crop of flax. In flax growing the heaviest draft falls on the nitrogen, but when clover is grown, the loss of nitrogen is not a serious matter, because one fair crop of clover will more than return all the nitrogen removed by two crops of flax. From our analysis of weeds, it appears there is in many cases more actual fertility lost in the weeds growing with the flax than in the flax itself. The great difficulty with the flax crop is due more to getting the soil out of condition than the removal of fertility. It is safe to say that with a proper rotation of crops there is no great danger of soil exhaustion from flax raising, and an average yield of fifteen bushels of flax seed per acre will remove less fertility than 150 bushels of potatoes, forty-five bushels of corn or thirty bushels of wheat.

PREPARATION OF THE SOIL.

Here the benefit of bearing in mind the fundamental principles is exemplified as a guide to practice, the observant farmer will note the peculiarity of the root system of the flax and be guided accordingly. This consists of a single tap root penetrating deeply into the soil, and taking its chief nourishment from below. It stands to reason that the deeper and more permeable the soil and seed bed can be made, the larger will be the crop of flax. Unlike wheat or oats, that tiller with a mass of fibrous roots, feeding near the surface and spreading out in every direction for nutriment. The flax root has few lateral fibers attached, consequently, to secure a close continuity between the root and soil, the soil requires to be compact below, friable and moist above, conditions admirably met by the system of Intensive Culture, and the practice of the dust mulch. The observance of this fundamental principle calls for deep plowing in the fall, rolling and surface stirring in the spring and modified, of course, with a dash of common sense to suit the local requirements. Light land requiring more stirring and rolling and heavy clay soils more stir and less rolling and to be got into a state commonly known as a light tilth, or like an onion bed. If clover sod is intended to precede flax, plow in the fall deeply eight or ten inches or more if possible, burying the sod well with a jointer or skim plow. If a hard pretentive subsoil exists, it will pay to run a subsoil plow in the furrow, breaking the hardpan to eighteen or twenty inches deep, but not bringing it to the surface. Smooth the land with a harrow and if the land

is light you may run a roller over it at this stage of the game, to compress the soil about the covered sod, and cause it to decay more readily. The winter frosts will lighten up the surface as early in the spring as you can work the land advantageously you can either plow again, this time only three or four inches deep. Or instead of plowing, work the land with a disc cutaway, Acme or spring tooth harrow and leave the land in that condition for a week or two in order to encourage the germination of weed seeds already in the ground and by again plowing or cultivating, the sprouted weed seeds will be smothered and a good seed bed for the flax secured, enabling it to get a good start. While giving the above, as what I consider the best preparatory treatment of the land for a crop of flax, I do not wish it to be understood that good crops of flax can only be obtained by this procedure, as many modifications may be made with satisfactory results, and it will pay in cash returns to keep close to the fundamental principles. Deep culture, compaction of the soil and fine and clean surface tillage.

SEED.

The seed question is of the utmost importance in flax culture for fine fiber, as only the best should be sown. Until the war, Europe was the only available source. In the near future, however, Puget Sound will produce an abundance of the highest quality of seed for fiber flax production. As a result of my experiments I have found that the Puget Sound grown flax seed contained 37.16 per cent of oil, and was richer in other respects, than any flax seed grown in any other part of America. Over twenty years ago I sent some samples of Puget Sound grown flax seed to the then President of the American Linseed Oil Trust, who wrote me that it was the finest sample of flax seed he had ever seen, and he kindly advised me not to ship it but to erect a small oil mill on Puget Sound. This is only in line with the well established fact that other oil-bearing seeds grown on Puget Sound, excell those grown elsewhere in vitality and richness, as illustrated by the circumstance that Puget Sound cauliflower seed, rape, and cabbage stand at the top of the market. Four varieties of flax seed are available for use on the North Pacific Coast, viz.: Riga, Belgian, White, and Blue Flowered Dutch, or Royal, and as far as my experiments have gone, good results have been obtained with all. It may be of interest in this place to note that in Ireland, the Dutch seed is considered the best on heavy crops, or after grain crops, while Riga is considered more suitable for light land, the Dutch is also thought to produce the finest fiber. This matter is, however, open to further investigation in this country, as many variations from European experience will be dependent on climatic differences. The finest of fiber is, however, dependent on the thickness or thinness of sowing the seed or any taint of mouldiness or mustiness. American seed that has been grown east of the Cascade mountains where it is sown for the oil mills is not adapted to

sowing for fiber production for the reason that being constantly sown thinly for the oil mills, it has acquired the habit of low-down branching, which spoils the production of long fiber, while the European seed permits this and so to speak, has been educated to produce a long straw with a few branches only at the top and will consequently yield a fiber of long staple.

Too much attention cannot be given to the production of pedigree seed for sowing purposes and every flax grower will do well to reserve a portion of his flax crop for sowing purposes, permitting it to ripen more fully, and preserve it carefully. It is also of importance to the flax grower to test the germinating quality of his seed some time before sowing. This is easily done by counting out one hundred average grains of seed and placing them between a few folds of cloth or flannel and put in a warm place, keeping the cloth constantly moist, but not wet. In a few days the seed will swell up and germinate if of good quality. If ninety grains germinate, it will require an addition of ten per cent to bring the lot up to standard. If only eighty per cent sprout, add twenty per cent. If less than seventy-five per cent sprout, better discard that lot of seed. None but the very best and cleanest seed should be used for fiber production, and if a farmer owns a fan mill, or can obtain the use of a neighbors, it will be of advantage to run his seed through it and separate weed seeds and defective grains. In the absence of a fan mill, the old fashioned plan of cleaning in the wind outside will repay the trouble and remove many bad weed seeds. The question of roasting the seed before sowing, using new or old seeds, soaking in water and afterwards freezing before sowing are all unsettled questions. It is therefore needless to encumber this monograph with their discussion. The change of seed rests on less indefinite basis as a change of seed has been found by experience to be of great advantage. Spraying the seed with forty per cent Formalin just previous to seeding is undoubtedly an advantage as a germicide rendering the flax immune to the flax wilt above spoken of.

SOWING.

Hitherto I have given directions for the general culture of flax applicable to all cases. Whether for fiber or seed or both, and we come to a fork in the road where we must elect what branch we propose to pursue. Here, also, we meet one of the distinctive features of my Americanized system adapted to Oregon and Western Washington and Puget Sound, the region of the United States par excellence, adapted to the production of the higher numbers and most costly fiber. (The Flax Heaven).

In growing flax for seed only the experience of the Dakota Experiment Station is instructive, showing that seeding at the rate of three pecks per acre, produced the maximum yield of seed, the yield decreasing or increasing as that quantity was exceeded or diminished. Consequently, farmers growing hundreds of acres for seed only, use this thin seeding and by use of the twine binder, harvesters and steam threshers, are enabled

to grow flax seed at a profit, although the average yield per acre was small and the straw broken and worthless.

In Ireland flax is chiefly grown for fiber and frequently the seed is ignored and the flax is pulled before maturity and is placed in the retting pools (with the seed on the straw) to ret. While in Belgium the flax is pulled in the dough state and let ripen on the straw after and used the next season for sowing, but the third season the seed is condemned to the oil mill. On the other hand the Russians let the seeds get firm and cut the heads off with a portion of the straw attached and tie them round a pole set up to dry. The Irish (when they do save the seed) as soon as the straw is pulled and dried, ripple the seeds off and spread them thinly to dry, often turning them to prevent mustiness.

The question arose here, How shall I Americanize all those varied processes to adapt them to our local conditions on Puget Sound? Fortunately, actual experience in the field has furnished me with the data for the purpose. In the Minnesota Agricultural Experiment Station Bulletin No. 40, a report is given of a series of investigations undertaken to demonstrate the yield of seed obtained from imported Riga and a native variety called "Fargo" flax seed. It was found Fargo seed yielded the largest crop of seed, being ten bushels per acre. This presumably with thin seeding as customary in that locality. During the same season, I was experimenting in flax culture for seed and fiber on Puget Sound when I planted $1\frac{1}{4}$ acres with Imported Riga seed at the rate of two bushels per acre (120 pounds) which yielded seventeen bushels of seed per acre, while another one and one-fourth acre alongside of it was sown with one bushel of seed per acre, yielded 16.3 bushels of seed per acre. Thus entirely upsetting the experience of Dakota and far surpassing the yield of Minnesota and illustrating the remarkable adaptability of Puget Sound to the culture of flax. This being strongly emphasized by the fact that owing to my not receiving the seed from Europe until six weeks later than the proper season for sowing in this climate, I had only what I regarded from former experience one-half a crop for the quality of land planted, and even then surpassing the best yield of Minnesota.

In view of this experience and the fact that thin seeding has a tendency to develop a branching habit in the flax to the great deterioration of the straw and thick seeding has just the opposite effect, I have adopted the distinctive practice for this region of sowing not less than two bushels per acre, two and one-half to three bushels being even better under any circumstances, as by that means we can obtain a larger yield of seed and of better quality than that grown east of the Cascade range, and at the same time, confirm and strengthen the pedigree habit of producing a long straw without branching. The only distinction I would make in growing flax for seed for fiber sowing would be on rich delta lands, allowing the plant to ripen fully and saving the straw as a waste product for the production of strong second-class fiber when probably one and one-half bushels

per acre might be sufficient. For fine fiber I would recommend two and one-half to three bushels per acre (160 to 180 pounds.)

SCAFFOLDING OR LANDERN.

Here we come to another interesting fundamental principle in European practice (originally adopted in Belgium) where the finest possible fiber was required, such as is adapted to the manufacture of "French Batiste" and the finest hand-made "Brussels Lace," and has been brought to such gossamer fineness that the fiber costs more than the actual value of the land upon which it has been grown and the Belgian Nuns were compelled to work it in damp cellars. The Belgian system of "Ländern" was so cumbersome as to be totally unadapted to our American ideas. In the first place they sowed three and one-half and even four and one-half bushels to the acre, and the very best and plumpest quality. Sowing so thickly of course had the effect of making the straw so fine and tall that it was unable to stand up against heavy rain or hail storms and to prevent this calamity, the growers drove posts into the ground about three or four feet high, and with poles and boards constructed a scaffold about eighteen or twenty-four inches from the ground. They then cut piles of birch twigs, spreading them on the ground and weighting them down with rocks and poles in order that they would dry in as flat a sheet as possible. After the seed was sown and the twigs dried in a mat, they were transferred to the top of the scaffold, as the straw grew it penetrated through the meshes of this mat of fibrous birch twigs which furnished the necessary support from being lodged by storms.

This doubtless was too cumbrous for the American disposition to cross lots and cut corners and get there all the same. How was I to give this difficulty a place in my Americanized system of fiber culture? After some study of the conditions to be met, I struck a feasible and simple course of procedure. Away back in the early forties (in my first kidhood) we used to plant potatoes in narrow beds all down the length of the field with narrow trenches between. The beds were generally three or four feet wide and the intervening trenches about twelve or eighteen inches wide. It was a simple matter to drive suitable forked stakes after the seed was sown in the beds and stretch common poultry netting along over the length of the bed and supported by the uprights. In localities subject to sudden squalls or hail storms a second additional strip of wire netting might be placed twelve inches higher up by making a still more efficacious support to prevent the flax being beaten down. This process is vastly more economical; when harvest time comes the stalks can be cut just above the roots with a sharp machete or other knife and the straw drawn up through the wire netting and rolled in compact bundles and stored from season to season indefinitely and the upright posts pulled up and stored as hop poles are stored from year to year for future use and the flax straw tied in usual bundles for retting.

SOWING THE SEED.

Sowing the seed rightly is a most important detail of the fiber industry, requires the greatest care, and if done by hand, considerable experience. Flax seed being so slick and slippery is likely to slip from the hand unevenly and thus produce a patchy and uneven growth; a very bad fault for the reason given before that uneven straw will ret unevenly, and requires grading, before retting at an increase of cost and labor. In sowing by hand the sower should follow the practice adopted in sowing clover seed, taking only a small portion of seed in the hand as a pinch between the finger and thumb at each cast and carefully avoiding any back cast. In Europe the sowing of flax seed is done by experts who go from farm to farm to do this work. My Americanized system entirely discards hand sowing, as the little American broadcasting machine (\$3.00) will do the work better and quicker and more uniformly than is possible by hand work. Another little American machine called a wheelbarrow broadcast seeder has been proved to do good work in sowing flax seed for fiber. Having your seed cleaned and tested and measured at the rate of 50 to 180 pounds per acre or such other quantity as may suit your requirements, sow it evenly if possible in the first week of April or as near that date as the condition of the land and season will permit.

In Ireland they fix on Good Friday as the date for flax sowing, while in parts of Sweden they wait for the 24th of July. On the Puget Sound, on the uplands from the middle of March to the middle of April will be about right, while in the Willamette Valley and Oregon, from the middle of April to the middle of May will be more suitable. However, never sow flax seed when the ground is wet, but wait a day or so, or it may be a week or more until the land gets into good condition, then sow, harrow and lightly roll and rest content you will have a good and profitable crop according to the care and intelligence displayed in carrying out these instructions. The spraying of flax seed before sowing with forty per cent Formalin is always of advantage and renders it immune from flax wilt.

WEEDING.

As I have already pointed out, weeding field of flax by hand is contrary to the spirit of the American people, and not included in my Americanized system of flax culture, yet this is a mighty great country and contains all sorts and conditions of men from many nationalities, some of whom are willing to adhere to their old country notions and practice and will consider it no hardship to weed flax by hand. I have nothing to say against this practice. Doubtless they will derive a benefit therefrom, but whether they will find it pays for the time and labor expended, I am not prepared to say. I have never weeded a field of flax, and do not intend to begin now at 85. I will, however, emphasize the point, **HAVE YOUR LAND CLEAN BEFORE YOU BEGIN** flax culture. Clean your seed before you sow it and you will not be

much troubled with weeds. NEVER PULL WEEDS IN FLAX UNDER ANY CIRCUMSTANCES WHEN THE GROUND IS DRY, as it will disturb the roots of contiguous plants too much and injure the crop.

PULLING.

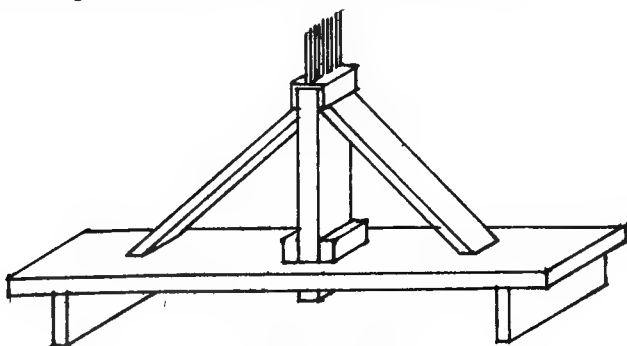
Having completed the sowing of his flax, the farmer is now at liberty to devote his energies to other matters, as the flax will not require attention until ready for pulling (in about eighty or ninety days) in this branch of the business several different lines of procedure may be followed, according to the results aimed at. If very fine fiber is required and the seed of little consequence, having sown thickly (two and one-half or three bushels per acre) the farmer will require to pull his flax pretty green or when passing from the milk to the dough stage and put the straw into the water, with the seed attached right from the field the day it is pulled. A practice only adapted to those having suitable water and retting pools within reach and some experience in retting. This is a system frequently practiced in Ireland, and certainly produces a very fine grade of flax. If the object is to produce a fair quality of merchantable fiber, and at the same time save the seed, he should pull his flax when the seed is in the dough stage and just beginning to turn color and the lower leaves have begun to turn yellow, but while the juices are still circulating in the stalk, in this case the farmer, if he has suitable water pools and skill he can either adopt the Irish system of rippling (that is removing the seed bols) and put the straw in the water to ret, while still fresh and green, or he can follow the Belgian system of drying the straw and storing it until the following summer, or he may sell the dry straw with the seed attached to the scutch mill and obtain spot cash for his product. Or beter still, if dealing with a co-operative association, turn his straw into the association for coin or stock in whole or in part, and save himself lots of work and worry. This latter will be the better plan for the average farmer, at least during the earlier stages of development of the industry, he will thus save the expense and labor of rippling, which is quite an undertaking where suitable appliances are not available.

It must be remembered that in this connection, the too early pulling will give a tender, though fine fiber that will waste considerably on the scutching if worked by unskilled workers. On the other hand, while allowing it to grow too ripe, will give a coarse and harsh fiber that lowers its value greatly, both of these faults must be guarded against by exercise of care and good judgment. I would therefore advise the inexperienced to be more guided by the condition of the seed than the straw until he becomes acquainted with the requirements of the industry. Judging of the maturity of the straw is somewhat embarrassing to the beginner, while he can always judge whether the seed is in the milk (not ripe enough) in the dough (just right) or fully ripe (too matured for best results). He will be pretty safe, however, if the seed is only beginning to change color from pale green to a light brown. I will here refer to one of the fundamental prin-

ciples before laid down. Fundamental principles being of more importance to the thoughtful and intelligent farmer than specific instructions, which may or may not be always applicable to the condition present. **BE SURE YOU HAVE ALL YOUR ARRANGEMENTS MADE BEFOREHAND TO SECURE PULLING AND ALSO TIEING OF THE CROP, JUST AT THE RIGHT TIME.** A man growing five, ten or twenty acres of flax would exhibit very poor judgment in providing the requirements necessary to harvest only five acres and would be sure to meet with disaster. As some guide on this point, I may say Mr. Eugene Boss in Wisconsin, had his flax pulled at a cost of five dollars per acre, if taking one man thirty hours to pull one acre. In Canada, also in Minnesota, about the same experience has been obtained. Flax-picking, like hop-picking, **MUST BE DONE JUST AT THE RIGHT TIME, OTHERWISE YOU WILL BE SUBJECT TO DOCKING IN PRICE.** I have tried as pickers, American men, youths, boys and Indians, and unhesitatingly prefer American men, unless you can procure Europeans, who have had practical experience in the fields. Boys are a nuisance in the flax field with the exception of just a few to set up the bundles of flax to dry. The Chinaman will make good pullers because they will do just as they are told like a machine. While Indians are uncertain and hard to teach. In addition to securing a gang of pullers to be on hand at the right time, it will be necessary to prepare ties for tying the flax in bundles. The Irish system of preparing before hand, large piles of rushes with loops at one end, which are used for tying the flax, those are delivered over the field by a boy in piles where convenient, and the men do the tying, hang as many as possible of those clumsy ties around their neck and draw one off to tie each bundle of flax when pulled. The Belgians and Germans using rye straw for this purpose, this practice is followed for two reasons: First, because it is wasteful to tie the bundles with flax, and, second, because the tie if made of flax, will rot as rapidly as the flax that it ties, causing the tie to break or get loose and the bundle to fall to pieces and require to be retted at considerable waste of labor and extra cost. In Americanizing, this European practice, I recommend the use of binding twine, cutting up the twine into strings about thirty inches long, of which a large lot can be carried hung around the neck and the labor of handling such bulky material as rushes or straw avoided. By having the strings all cut the same length and a suitable loop on one end of each string, much time will be saved and the size of the bundles will be more uniform. Having your ties and pullers in readiness and the flax in the proper state of maturity proceed to the field and commence pulling as follows:

Gathering up a bunch of flax tightly a little below where the branches start with both hands, your arms are lifted with a jerk upwards, which draws the roots from the ground, still continuing to lift the hands until the roots of the pulled flax in handfuls are clear of the top of the flax still standing with a kind of sweep, you bring it over until the roots strike the ground

with the roots all even together. While making this movement if any earth adheres to the roots, which will probably be the case on clay land, strike the roots smartly against the ground or your boot to knock off the adhering earth before laying it down. Then, with the right hand edgewise and the thumb turned down, with a back-handed sweep, gather up another bunch of flax to the left hand and repeat the motion until the left hand is full and pull it as the first bunch was pulled and sweeping it over and laying it over across the first in such a manner that the tops of each will not become entangled. Continue thus until you have enough piled together on the ground to make a bundle large enough to fill your string, then continue pulling in the same manner and making other heaps as the pulling progresses. You can either tie the bundles at once or leave the heaps of flax on the ground for others to come along and tie. It will be better to let tiers tie, and pullers pull, as by so doing you make a division of labor, and both become more expert in their different branches of the work. When tying, the bundles should be gathered together and lifted and the butts struck ("jabbed" would be the more expressive word) on the ground to get all the roots as even as possible and then tie moderately tight just below where the seed ends branch off and set them up singly with their butt ends spread out for the purpose of drying. At this point the farmer elects what disposal is to be made of his flax, whether he will ret it himself or sell the dry straw to the scutch mill. In the former case, he can adopt the instructions here laid down, although I have thus been particular in describing the details of hand pulling flax the Americanized system contemplates this work being done by machinery, as flax-pulling machines have already been invented, and I trust will shortly be placed on the market by the use of which not only the cost of pulling, but also the time occupied in that process will be greatly reduced. Our American harvesting machines are now so much improved that they can be set up to cut flax straws within two inches of the ground and with very sharp knives may be substituted with economy for the pulling.



FLAX RIPPLE

I have now come to a phase of my subject that will cause European experts to hold up their hands in holy horror at the

innovation, to elaborate a distinctively American system of flax treatment, however, requires, while giving due consideration to the experience of other and older countries, an independence of thought and action untrammled by any fear of "what will they say in England," at a departure from their honored customs.

The question before me is, Why is it considered in Europe so absolutely necessary to pull flax instead of cutting it? The cost of pulling being two or three times greater than of cutting and occupying a much greater time at a season when prompt and rapid work is of the greatest importance. When I began to investigate this question and interview European experts on the subject, I was met with several objections more or less theoretical and entirely unsupported by actual personal experience in cutting flax, as contrasted with pulling it. In fact, many criticisms were entirely imaginary, the gravamen of their arguments, if epitomized, would amount to, "My father, grandfather, and their ancestors all PULLED FLAX, THEREFORE THAT MUST BE THE RIGHT WAY. WHAT BUSINESS IS IT OF YOURS TO CRITICISE OUR EXPERIENCE ANYHOW?" and to clinch the matter beyond any farther question. FLAX IS ALWAYS PULLED IN EUROPE, and that settles the question to their own satisfaction, but certainly not to mine.

The principal objections to cutting flax for fiber and in favor of pulling it that have been given me are: First, flax is pulled in order to remove the roots from the ground. This is in view of the important discoveries of Mr. O. Lügger, that the debris of the flax crops remaining in the ground was injurious to succeeding crops of flax (details of which have already been given) is the most feasible argument that has been given, yet a little consideration will show its want of force. The fact of the roots of flax remaining in the ground really cuts no figure in the matter, as with an interval of four or five years and upwards in cultivation under other crops before flax is again sown on the same land, the roots of the former flax crop will have been decomposed and removed.

Second, cutting flax wastes too much fiber owing to the length of butts of straw left on the ground. This is also at first sight plausible and was originally based on the old fashioned implements used for harvesting grain, (such as the hook, scythe and cradle). Our improved American harvesting machinery (Deering, for instance) can be made to cut so close to the ground if it has been properly tilled and leveled that little waste of material will occur, and it will be more than offset by the great saving of time and cost. In this connection it is well to remember that in some of the districts of Belgium where the best grades of flax are produced are chopped off with a large knife before scutching. There would be no greater loss of material by cutting in the field than the Belgian producer experiences by cutting after retting.

Third.—The reason that flax pulling was adopted instead of cutting was in order to avoid weeds in the flax and the party making this statement added, "I see no reason why flax should

not be cut in the field by machinery if the land is perfectly free from weeds and THE KNIVES VERY SHARP, nor will the flax be injured in anyway by cutting." Now as the keynote of this system is WEEDS ARE DEATH ON FLAX, we should have our land clean and smooth and then cutting would meet the requirements without any objection. A thought here occurs, a point worthy of consideration. There are weeds and weeds, some are of a fibrous construction upon which retting has the same action, as on the flax itself and if any such become mixed with the flax it will reduce the value of the fiber, being hard to separate one fiber from the other. Of this class of weeds are bindweed, milk-weed, nettle and others. There are also weeds of a cellular or herbaceous character that dissolve in the retting tank and are separated from the flax in the form of dust in the scutching. Mares-tail (*Equisetum*) is one of that class, they are no injury to flax fiber. On one occasion I had a field of flax so overrun with this weed that I dispaired of any return, but to my surprise, after retting and scutching, not a trace of mares-tail was to be found. The point of interest is, that some weeds are injurious to both straw and fiber, but ALL WEEDS are injurious to the crop of flax by robbing it of its proper nutriment and stunting its growth. Another expert informed me "you cannot cut flax for the reason that the square cut ends of the fiber will not work well in the machines, and will show in the finished goods." At this place I will mention a fact I do not think I have referred to previously. One of the fundamental principles we meet with in flax culture that for one or one and one-half inch above the crown of the root of the flax fiber does not exist and consequently with American harvester or fairly level land can be made to cut the straw at one and one-half inch above the root and consequently without any waste whatever of fiber.

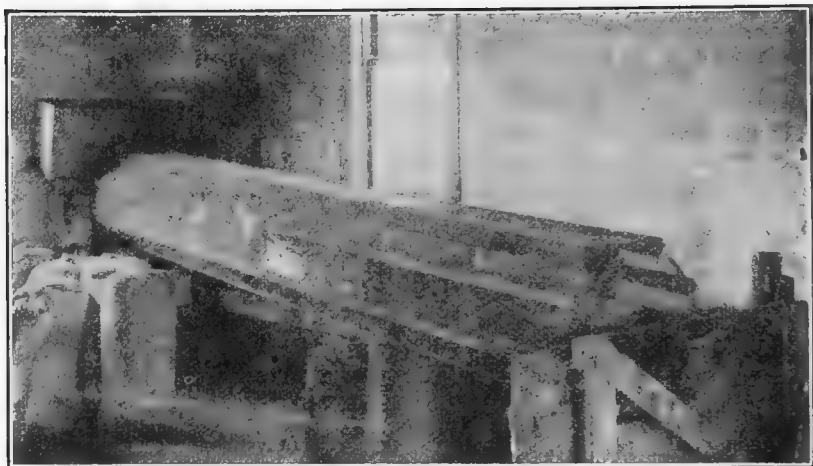
This argument against cutting is entirely imaginary, it is an established fact that in Belgium, THEY DO CUT THE BUTTS OFF BEFORE SCUTCHING without any such results. Not only so, but Mr. Frank Barbour of the Hilden Flax Mills in Ireland, informed me that in their mills they cut the flax fiber into three lengths with a machine resembling a circular saw, they are called "butts," "middles" and "tops" and the middles are used for the finer grades of yarn," though cut at both ends.

Another says, "that cutting the straw will allow the water to enter the hollow at the butt and allow the butts to ret more rapidly than the rest of the straw, causing uneven retting. This argument might have some force if flax was like wheat or oats with nodes, forming a separate chamber in the straw which obstructs the passage of fluids but the hollow in the flax straw runs the whole length of the straw without obstruction. The effect of this would be to allow the water to enter and flow the whole length of the straw and act simultaneously upon the inside as well as the outside of the straw, thus cutting short by one or two days the process of retting, a most desirable result.

Having considered the argument opposed to cutting flax by machinery, I will refer briefly to some arguments in favor of this

practice. Rapidity of work, this is an important consideration. Flax very rapidly deteriorates by over ripening and the shortness of the season for pulling necessitates quick work. One good flax puller may pull one acre of flax in three days (thirty hours) while an American (Deering) self-binding harvester will cut and tie five to ten acres or more per diem, consequently a much more expanded area of flax can be harvested by machinery. It follows from the above that the saving in cost by this practice will be considerable. In Canada and Minnesota five dollars per acre was paid for hand-pulling flax and on the Pacific coast the wages are much higher. While with an American harvester the work can be done for one dollar per acre or less.

While I have no doubt that in the near future a practicable flax puller will be on the market until that time arrives, I would recommend the practice of cutting flax with a suitable machine and if the cutters are kept sharp enough it will be found more economical, more rapid and more distinctively American.



DOMESTIC. SEED GRADER

RIPPLING.

Rippling or removing the seed bols may be accomplished in the field or barn, according to circumstances, in the field when the farmer is desirous of retting his flax green, and fresh from pulling, if the weather is favorable (which it generally is at this season), a good wagon sheet may be spread on the ground or on a wagon bed and the ripple placed in the center. There are several kinds of ripples, some are elaborate machines, others are so simple any man handy with farm tools, a saw, hammer, draw-knife and few twenty penny spikes and gimlet were all I required to make my own ripple in old pioneer days, and a simple way to overcome this difficulty, is to ignore the rippling altogether and sell your flax straw to the scutch mills with the seed on. The farmer's ripple can be operated by one or two

men and consists simply of a plank 6 feet by 10 inches by two inches with two support 12 by 2 feet by 2 inches. In the center of the six-foot plank is morticed an upright piece of plank of similar width, two feet long, one end of which is capped with a piece of sheet iron 6 inches by 2 inches, being lapped all around the upper end and along the middle of the sheet iron a line nearly the width of the end of the upright plank large enough to allow sixty penny spikes to be snugly driven. These holes should be driven 13-32 of an inch apart. The spikes, first having their heads cut off, are driven perpendicularly, head end downwards with the points projecting. These spikes are driven two inches into the wood uniformly spaced and straight like a comb. The other end of the upright plank is cut to a tenon 6 inches to the shoulder of the tenon and 2 inches by 4 inches in size to fit down crosswise through a mortice in the ten-inch plank. A hole should be bored through the tenon one inch in diameter with its center just $2\frac{1}{2}$ inches below the shoulder through which a one-inch pin is driven underneath the long plank for the purpose of stiffening. Two $1\frac{1}{2}$ -inch cleats should be nailed snugly on the upper side of long plank to further stiffen and support it and still further a couple of braces as shown, as the upright is subject to considerable strain. (See cut of Ripple on page 41.)

To work this ripple one or two men or boys can sit on either end which may either rest on blocks or have fixed legs attached and taking a bunch of straw not larger than they can hold tightly in both hands strike the seed end of the bunch down on the teeth of the comb two or three smart blows in succession. The bols will be pulled off and fall to the ground. If two persons are working together they should sit one on either side of the upright comb and deliver their strokes alternately in regular rhythm. Strike only a small portion of the seed end of the bunch over the comb, the first stroke, each succeeding stroke being made farther along the straw until all the seed bols are removed. When one bunch is cleared of seed it is placed alongside of the operator and another bunch immediately taken, and when sufficient straw has accumulated, it should again be tied in neat bundles to load conveniently. They are tied with three pieces of baling twine or bale rope in neat bundles about six or eight inches in diameter one tied at each end and the one in the middle with the butts very even and it is then ready to put in the water, these beets should be tied tightly and the larger beets are the easier of transportation and less bale rope is required. To make these beets of good shape and tight enough for safe handling, a rough box frame or box open at the side and top and closed at the ends just long enough to hold two bundles apart overlapping in the center, can be made, and large enough to hold just the proper number of bundles without much pressing. When the box is full of bundles, they can be compressed very compactly.

In filling the box see that the butt ends of the straw are evenly pressing against both ends of the box and the seed ends overlapping in the center. When the box is full of bundles they can be easily compressed with a lever or a Mexican windlass,

and tied and rolled out. If the farmer is near enough to the mill to haul the flax in his own wagon, this baling will not be needed; but if required to ship by train or boat the baling will be indispensable. In any case, the extra trouble in making neat beets will amply be repaid by the more ready sale and better price obtained.



The Seed Rippler and Cleaner.

RETTING.

This is the most important manipulation in the flax industry, and if attempted by parties unskilled in the work may utterly ruin the value of the flax crop. In Ireland, the farmer does his own retting, and stores the dry retted straw, in stacks, which are carefully thatched with straw, or rushes in which condition it will keep indefinitely if properly dried out before stacking. He generally takes it to the neighboring scutch mill, to have it scutched, and sells it to the brokers, who travel around the country, or to the spinning mill, if one happens to be in his vicinity. The Irish farmer generally paying the scutch mill, one shilling per stone, (25 cents per 14 pounds) for dressing it, leaving the tow with the miller. This is objectionable, as the small mills can, and do frequently allow an undue quantity of waste, to go over the scutching arms, which they work up afterwards for the mill's benefit, and great loss of the farmer.

In Holland and Belgium, the farmer frequently grows the crop and then sells the crop to the broker while growing. The broker sending his own men to do the pulling and attends to the retting himself. It is probable that this will be the best plan adapted to the north Pacific Coast, it will consist of the formation

of strong joint stock companies with ample capital, to make cash contracts with the farmers to grow under special instructions, furnishing the seed at cost price and "Spot cash" (or stock at his option), on delivery at the mill. The company conducting all the technical work of pulling, thrashing, retting, and scutching, with skilled operators, and improved, and the best labor-saving appliances. It will always be the best policy of such companies to give the grower the best possible price justified by the quality of the flax, and the care bestowed on it, by the grower in order to encourage him to continue the culture, enabling the mill to work all the year to its full capacity, and also encourage him to turn his earnings into capital stock and increase his personal interest in the success of the company, in fact any other policy would only be an aggravated case of "killing the goose that laid the golden eggs." To provide good retting the all important conditions is good suitable water. Where this condition does not exist it must be provided artificially or the system of water retting of flax be abandoned for the far inferior system of dew retting. To illustrate, I will quote an interesting case. A Mr. Luppens, a Belgian flax expert, invented a system of tank retting of flax which was very successful when operated with the river Lys water which was acknowledged by experts at that time, (25 years ago), to be of unsurpassable quality for retting flax. Mr. Frank Barbour at that time was operating on some Puget Sound Flax I had sent him when he called my attention to Mr. Luppens' invention and kindly forwarded me some very beautiful samples of Mr. Luppens' products with the following remarks:

"I send you some of Mr. Luppens' tank retted flax from Courtrai. I am afraid he has sent you too fine a quality, but I have myself seen some of his samples that were the finest I have ever seen."

Since the war in Europe, and the phenomenal advances in the market price of all grades of flax, some capitalists in Minnesota sent to Mr. Luppens to induce him to visit Minnesota to erect a battery of retting tanks, and after heavy expenditure of capital and a great flourish of trumpets the result was an utter failure. The water had too much lime in it, which would have been discovered at first if he had only washed his hands with some soap in it!

POOL RETTING AND STACKING STRAW.

Shallow soft water ponds or lakes furnish suitable conditions. Cheap dams in low places or the plow and scraper may be used to advantage, but the water must be soft, and without lime, must be secured in the first instance. A pond 50x94 feet will hold the product of one acre of flax. It is well not to make the pools deeper than four feet; the water attains a higher temperature than if deeper.

The pools should be prepared in the winter, and a few small pools will be more easily managed than a larger body of water. An open position exposed to the sun, will be better than one heavily shaded with timber. Here we come to the disputed point in

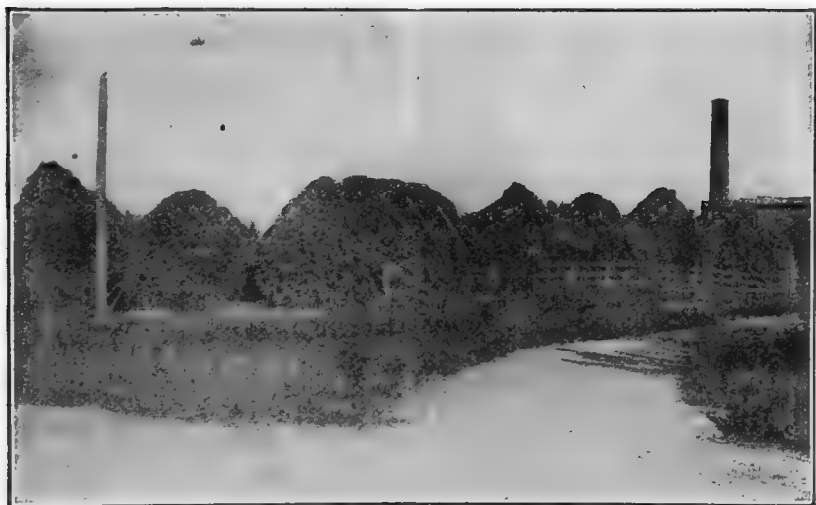
practice which calls for some consideration. In Ireland, they say, "Do not put two successive lots of flax in the same water," while in Belgium they are not so particular. And for twenty miles along the river Lys the water is crowded with flax in the process of retting, all summer, and is so thoroughly impregnated with the results of flax fermentation that it becomes an ill flavored fluid, both to the eye and nose. On Puget Sound, (where my investigations have been conducted), my experience shows that this is not a matter of very great importance, as I have had flax retted with only one lot in the same water and again on other occasions I have had as many as three lots retted in the same water, successfully, and that too in a very small pool, without any great difference in the result. If you have a supply of soft warm water, which you can draw from, at will, in some lake or stream at some higher level so that you can run it into your retting pool or tank, when required, and fill or empty them at pleasure, it will greatly facilitate matters to set your dry straw in your retting tank and weight it down before you let the water run in, and when the fermentation has reached the proper stage, drain off the water before moving the wet flax to their drying place and immediately fill your empty retting tank with a fresh lot of dry flax, and turn on the water again. The foregoing are at the base of the most successful system of water retting yet discovered and embody the claims of Merris Luppens and Deswartes' invention, the American patent on which has now run out and it has become public property and is free for general use.

There are several modifications of the retting process, a few of which only I will here describe, the best of which is the Luppens & Deswarte of Neerpelt, Belgium.

The special advantage of this system is that it supplies a system of retting Flax, Hemp and Jute in running water without the danger of contamination of the river and streams, which in thickly settled districts of the United States would never be tolerated. The upper part, which contains the flax to be retted, separated from the lower part by an open floor. Its walls are vertical, and means are provided to keep the flax straw suitably immersed. These consist of cross beams working in vertical slides and adjustable at any required height. The lower part in which the renewal of the water takes place is situated between the bottom of the tank and the open floor. Fresh water is admitted by an inlet just close beneath the open floor, and outlet for the used water is made through the bottom.

The flax straw is tied up in double sheaves, the root end of one half along side of the top end of the other, and approximately cylindrical in shape. These sheaves are placed on end on the open floor moderately close and as regular as possible. Ordinary straw is then spread over the top to keep off dust, or the effect of weather, and boards are placed on this to equalize the pressure of the cross beams to insure the straw being suitably submerged when the tank is full and working. The tank is then filled by opening the inlet and closing the outlet, and as the level of the water rises, the straw rises also, till it is stopped by the crossbeams

where it remains motionless, pressing upward all the time more or less. The outlet, and inlet are next regulated so as to insure the water being suitably renewed and maintained approximately at the same level. The changes which occur in the retted mas may be set down as follows: The water surrounding the stalks dissolves the various vegetable substances, some of which are naturally soluble, while others become so successively under the action of fermentation. Thin streams of heavy juice are thus formed which flow down the stalks and slowly cross the layer of fresh water below the retting mass, and this without mixing with it, owing to the extreme slowness of their motion. On the bottom of the tank these then form a layer of dirty and denser water, while at the same time the fresh water of the upper layer works its way up into the retting straw, also in the form of thin streamlets, which take the place of the decending ones. Owing to the vertical position of the stalks and the equal pressure all over the tank, these



Flax Storage and Retting Ponds

movements take place with equal facility throughout. As regards textile straw, this system is therefore characterized by the vertical circulation of the water under the influence of gravitation alone. This circulation, consisting of the natural fall of the heavy juice and the corresponding rise of the fresh water takes place uniformly and to the exclusion of every other motion in all parts of the retting mass.

Some of the claims of merit put forth by the inventors, which in a majority of cases are based on experience, may be enumerated as follows: (1) The possibility of natural retting in running water. That is to say, the best possible retting in whatever water is obtainable. (2) The greatest uniformity obtainable in retting. (3) Larger yield of fiber. (4) Results certain and invariable. (5) The saving of labor. (6) Limits the water con-

sumption to what is strictly necessary for natural fermentation. (7) Full benefit derived from the water used in retting. (8) Rivers not contaminated. (9) The preparation of the fiber preserves its agricultural character. (10) Farmers can themselves continue to prepare the fiber of their crop. (11) May be carried on in establishments of every degree of size or completeness. (12) Suitable for the treatment of textile straw of all values, from the finest flax to the coarsest hemp. (13) Practicable in almost every country in the world where flax or hemp is grown.

U. S. Patent for Retting of Hemp and Jute; invention of Messrs. Luppens and Deswarte, No. 576,867; issued February 9th, 1897; patent gone out of force and now public property for general use. May be obtained from U. S. Patent Office with full specifications and drawings, price five cents.

The use of tanks with false bottoms for artificial retting was first adopted in America by an American named Schenk. The use of tanks Schenk's system called for the use of hot water, known as the American system. Others were tried, both in America and Europe. The most successful was the above described Luppens & Deswarte tank, which was a cold water system. Tank retting in Mr. Brown's Microbe process, and also there was a system called Mr. Boyce's Oliagenous Soap System. None of the tank systems (except the Luppens) stood the practical tests of the spinning machines, and even the plausible use of yeast solutions, to hasten fermentation, also failed to materialize.

The present fundamental principal concerning water retting is that no river, pond, reservoir or tank will yield satisfactory results, IF THE WATER USED IS UNFITTED FOR THE PURPOSE, except Dew Retting, and that only utilizes the pure dew of Heaven and the summery showers. Of course dew retting does not secure as good or high priced quality of flax as suitable water retting will produce, and as more than three-fourths of all the flax retted in the United States is dew retted, I cannot exclude it from my distinctively American system of fiber culture, and truly, with all its faults, it occupies too important a place in our system of fiber production to be ignored. Dew retting then is accomplished by spreading the flax straw in thin layers on grass fields or meadows where it is exposed to dew and rain for two or three or more weeks, according to the state of the weather, and turning it from time to time, as required. The turning is accomplished by pushing a long pole under the flax straw as it lies on the grass, turning it clear over. The ordinary test of the completion of the retting is made by taking a few straws in both hands, with hands held about four inches apart, backs of the hands upward, and backs of the thumbs inward, and rubbing the straw up and down between the thumbs to break the woody part of the straw, and if the fiber separates freely from the central core it is sufficiently retted and may be tied into shocks and stood up in the field with the butts spread to facilitate drying.

That the American system of flax treatment will utilize some form of tank retting, I have no question, probably with arrangements to secure a permanent artificial summer temperature, not

however, to exceed 68 to 70 degrees F. all the year round. Why should not large glass structures similar to those enormous winter vegetable forcing houses, now so common in the United States, be constructed with suitable tanks and drying racks? Then flax and other fiber retting could be carried on winter and summer and the scutch mill be kept in active operation to its fullest capacity all the year? Some such arrangement will be necessary to satisfy our American progressive and high pressure ideas. In Europe, the scutching mill plant is laid off for several months while all hands are employed in bunching, tying and retting the flax. When that is accomplished all hands are started at the scutching mill, thus allowing a large portion of the invested capital to lie unproductive for months, seems to the ordinary American investor to say the least, a very unbusinesslike proceeding and calls for Americanizing by enlarging the retting facilities and keeping the scutch mill in operation without intermission. Thus by letting the tiers tie and the bunchers bunch, and the scutchers scutch and retters ret, a division of labor would be effected that would vastly increase the skill and dexterity of the individual operatives and largely increase the financial return.

In water retting whichever process is adopted, the flax in pool retting must be visited every day for the first three or four days to see that the flux has not risen out of the water, and if any signs of its coming to the surface are observed more weight must be added. When the fermentation has well advanced the flax will sink and settle down. It must then be examined frequently.

Just here comes a radical difference in practice, in the two great flax growing localities. The Irish leave the straw in the water until retted sufficiently and then take it out and spread it very thinly on the grass to dry and bleach. This is called "grass-ing." While the Belgian takes it from the water before the retting is completed and stands the bunches in the field to dry, packs it in the crate and again submerges it for a few days or more until completely retted. Sometimes it is even taken out and dried and submerged a third time. In view of those diametrically opposed systems, retters, each claimed by experience, to be the best and both producing good results. THE WIDE AWAKE AMERICAN with the habit of cutting corners, is fairly justified in striking a new trail. However, the double retting has been so fully demonstrated as far superior to the single ret that I strongly recommend it in all cases. See Mr. Barbour's report hereto appended. In this matter of double retting it will be instructive to consider the fundamental principle upon which it is based. Retting has for its object the removal by fermentation, of the pectose and gummy matter which binds the flax fiber together. This fermentation first renders the pectones soluble and afterwards dissolves it away. Now in the single retting the fermentation, after rendering the pectose soluble, continues operating on the flax at the expense of the quality of the fiber, while the pectose is being dissolved, and before completion of its removal. On the other hand in the double retting the fermentation is only allowed to proceed far enough to

render the pectose soluble and then by removal of the flax, which still contains the pectose but now in a soluble form. The flax is now dried and returned to the water. The water now immediately commences to dissolve the soluble pectose before a fresh fermentation has time to be set up, consequently the fiber is uninjured and a more valuable product is procured as the result.

As the duration of the submergence depends in a great measure on the temperature of the water and conditions of the straw, coarse straw retts more quickly than fine and no fixed time can be set. Each lot of fax must be treated as separate entity and varies from five to fifteen days. As before said, the straw will first have a tendency to rise to the surface of the water and the gas will bubble up. The straw then softens and sinks. When this occurs it must be closely watched and tested from day to day as well as several times a day. When found to respond to the several tests, it must be removed without delay.

The following are some of the tests generally applied: Some straws (a dozen or two) are pulled out from the center of a bundle and taking them in both ahnds with an interval of two or three inches between the hands, it is crumbled up by rubbing together between the thumbs. If the chive breaks short off and separates freely and the fibers are easily separated from each other it is retted enough and must come out of the water. Before removing this test should be applied to several bundles taken from the different parts of the pool. Left longer in the water it becomes harsh and the life and softness will be taken out of the fiber and is called "water slain."

Again, take three or four straws which will be covered with a green slimy substance. If this can be wiped off the surface by delicately passing between the finger and thumb, it is an unmistakable sign of sufficient retting.

Again, bend a single straw over the forefinger. If the chive freely separates and starts up from the fiber, it is retted sufficiently. Retting is the most critical and important process in flax manipulation, as either under or over retting affects the flax injuriously. As soon as the proper stage of retting is reached, as shown by the above tests, the flax must be removed from the water and allowed to drain for a few hours and then set up to dry.

GRASSING.

After the flax is taken from the water and has drained awhile, the bundles are untied and spread very thinly upon the grass to dry and bleach for eight or ten days, according to the Irish system. This is another troublesome and unnecessary process that my American system may ignore with profit. I have tried this grassing process along side of the Scandinavian plan of drying astride a fence or poles set up for that purpose, with no material difference in result, except that this grassing requires three times as much surface of ground as it took to grow the crop. It is not always practiceable. Consequently, I cut off another useless corner, in this American system, and instead recommend a modification of the

Scandinavian practice, by having galvanized wires stretched on frames set up for that purpose in the drying ground. These wires will last for years and the frames may be removed at any time the ground is required for other purposes. For this purpose the bundles are taken from where they have been left to drain and the tie opened out, and the whole bundle placed astride the fence, pole or galvanized wire, set up for that purpose.

After a few days when the butt ends are dry the bundles are taken down and the tie or band slipped back to the butt ends, and the seed ends opened out and the bundle reversed on the wire until the whole is sufficiently dry for housing, when it may either be taken to the mill and sold, or stacked and covered safely from the weather, in which condition it will keep indefinitely. While drying on the wires many bundles of the straw will be found to be stuck or matted together, so that air cannot permeate through them. A stroke of the bundle against the ground will loosen the straw and allow the air to pass freely through and dry the straw more rapidly. This completes the farm work on the flax crop.

WHAT IS THERE IN THE FLAX CROP FOR THE FARMER ANYHOW?

In reply, I will give a few pointers from which you can figure it out for yourselves. In the first place it must be remembered that flax is preminently a MONEY CROP, for which the mill will pay SPOT CASH and it is the policy of the scutch mill to give a good paying price to encourage him to continue in its production. Any other policy would be suicidal to the miller, as unless the farmer secures a fair profit for his flax, he will discontinue to produce the scutcher will be left with a costly mill plant on his hands, both idle and unproductive.

Flax is not like other crops, that the small farmer is compelled to trade with the merchant and accept goods therefor in lieu of cash. As an old Dutch neighbor of mine said, "IN MY COUNTRY THE FLAX FARMER IS ALWAYS THE BEST FARMER, AND THE FLAX FARMER ALWAYS HAS THE BEST CLOTHES, AND THE FLAX FARMER ALWAYS HAS SOME MONEY IN HIS POCKETS." The careful farmer may expect three to four tons of dry straw, with the seed on, to the acre, if he has used reasonable care and attention in the various details of culture and treatment as here laid down. Should he be slack handed, he had better let the flax culture alone.

A crop of flax, such as would yield three to four tons per acre, would run from thirty-six to forty-eight inches long in the straw measured from the crown of the root to where the first branch starts from the stem. This is no unusual growth for Puget Sound or Western Washington, while with the extra care in favorable seasons very much better results may be obtained.

A POINTER.

Owing to the demoralization in the flax industry by the European war, the market price having advanced over 500 per cent from what it was before the war, the prudent farmer should secure in his contract with the scutch mill, an option to require either "cash" or stock in the company. If he sells his straw for cash, he will get a good price for it, but if he insists on getting stock he becomes a partner and secures his full share in the profits of the growing manufacturing branch of the business, as such mills are classed as co-operative.

WHAT IS THE COST OF GROWING AN ACRE OF FLAX?

I give a couple of practical examples of which any experienced farmer may judge for himself.

NO. 1		NO. 2	
Fall plowing	\$2.00	Spring plowing	\$2.00
Subsoiling	2.00	First harrowing .....	.50
Harrowing .....	.50	Second harrowing .....	.50
Spring plowing	2.00	Rolling .....	.50
First harrowing .....	.50	Sowing and covering.....	.75
Second harrowing .....	.50	Pulling and tying.....	6.00
Rolling and planking.....	.50	Hauling to mill.....	3.00
Sowing and covering.....	.75	2½ bushels seed.....	7.50
Pulling and tying.....	6.00		
Hauling to mill.....	3.00		\$20.75
Three bushels seed.....	9.00		
	\$26.75		

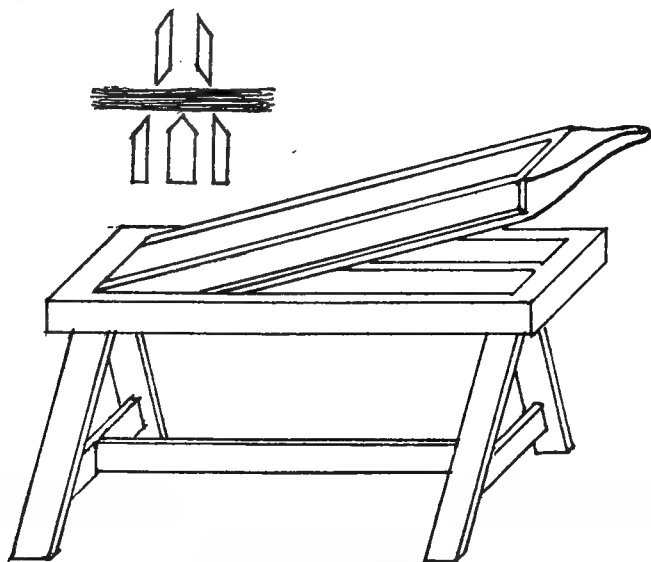
Whenever possible, I recommended No. 1, though costing six dollars an acre more than No. 2, yet the heavier seeding and the better tillage will yield a flax of a finer quality and for which the mill will pay a higher price and will also yield a heavier crop to the acre. It must be here noted that this cost, with the exception of the seeds, is not cash outlay, but ordinary farm work and in any case the cost of the seed is advanced and not paid until after it is earned. It must also be remembered that the foregoing is based on the establishment of a scutch mill in the farmer's vicinity. Now in regard to the farmer breaking and scutching his own flax. A few remarks may be of interest in this case. This is a distinct industry for the flax scutching mill and the flax spinning mill are two very different establishments. The scutch mill takes the flax straw from the grower and rets it, then breaks it, then scutches it, and makes what is called "scutched flax" or long "line" for the spinner. The scutch mill may or may not (at their own option) go a step farther and hackle this long line or mill scutched flax and produce what is called "dressed line" of different grades for the spinner. This is a much higher-priced commodity and frequently the spinner does the hackling to suit particular requirements. The spinner requires a large, costly estab-

lishment and employs a large force of skilled operators. His chief effort is to produce threads, warp yarns of endless grades for the weaver, who weaves those yarns into various fabrics. To recapitulate: We have the farmer grow the flax, the scutcher rets and scutches it for the spinner. The spinner spins it for the weaver and the weaver weaves it into fabrics for the general consumer. If therefore the farmer has the necessary skill he can with very little outlay scutch his flax by hand and with proper care can produce a better grade of line, than the mill can. Of course, he cannot compete with the mill in quantity. It is the fine quality that brings the high price. However, that price is so high for the finer qualities of line that the farmer with a family will find it profitable to have a crop of flax every year to work during spare hours. If the careful, industrious farmer can, during the slack time of the year, scutch ten to twenty pounds of flax, as the Belgian farmers do, and that flax is worth fifteen cents per pound, and upward, and the breaking and scutching can be done in the house or barn during the winter, it requires little argument to show the profit of the business, more especially when any handy man with only the tools to be found on any farm, can make the necessary implements without cash outlay.

Before undertaking the hand working of flax, some considerations of details are in order. The farmer has to contend with the disadvantage of not furnishing a sufficient quantity of any one grade to make it an object to the spinner. It will be well to have a standard to work up to. The points that give value to scutched flax are, fineness of fiber, softness, strength, length, color and perfect removal of every atom of chive or woody material. Length of straw and fiber depend on climatic conditions, suitability of soil and the thickness of seeding and care in culture, consequently, are influenced in a great measure by the grower. Fineness of fiber depends on quality of seed used, quality of land and thickness of seeding and is therefore modified more or less, by the good judgment exercised by the grower. One may grow flax capable of yielding the softest, silkiest and strongest fibre and yet have it entirely spoiled and life taken out of it by careless or improper retting. While the removal of ALL the chive or wood material wholly depends on the care, and thoroughness of the producer's work. This is why there is such a variety in the quality and price of scutched flax, and why the Russians and Irish flax producers do not obtain the same high price for their flax that the Belgians and Hollanders do. Because the Belgians and Hollanders are more careful and painstaking (call it plodding if you will), attending to every little detail and only satisfied when he can say, "That is just right!"

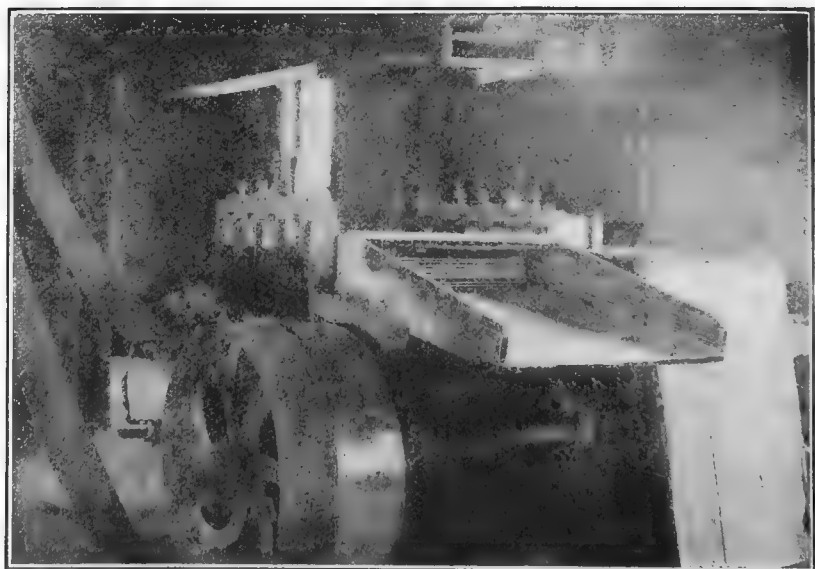
The Russian and the Irishman, on the other hand, go to work in a slipshod manner, inattentive to minor details, and are satisfied with "Oh that is good enough" or "That will do." These remarks refer to the average producer in these different localities, and the facts are well known by spinners by sad experience. The one secures the top price of the market, while the other is docked in price, to pay for his carelessness.

The hand break for flax and hemp is a very simple tool and can be made by any handy man with the ordinary tools on the farm, out of the maple, willow or other tough wood that he can procure.



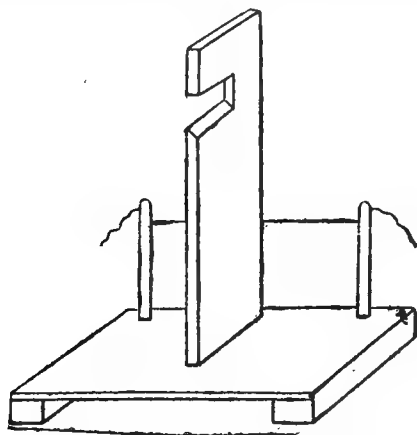
Hand Flax Brake

Although I have seen good flax produced with an ordinary beetle on a block of wood, in order to do good work with this



Power Flax and Hemp Brake

brake the straw must be dry. Frosty weather is well adapted to the work as it can be done in the shelter of the barn. Sometimes fires are built and the straw piled around it, but I would be very shy to recommend fires and flax straw being brought in close proximity. Braking is performed by pounding and pressing small handfuls of straw between the moveable arms of the brake until the woody part or chive is broken into short pieces, rendering them more easily removed, by the subsequent process of scutching. In the process of scutching the fiber is separated from the tow and much tow is carried over the scutching blades, by incompetent operators. As it is difficult for one to learn from mere



Domestic Scutching Board

written instruction, it will be well for parties contemplating flax culture to consult some of their European neighbors, who came from flax growing regions, Irish, French, Belgian, German, Dutch, Russian, Scandinavian, Austrian, etc., and while each nationality may vary in their views, do not put two men of different nationalities to discuss flax together, unless you wish to have a lively cat and dog fight on your hands.

In this place I cannot do better than give an epitomized account of Mr. Frank Barbour's report, on one ton of Puget Sound fiber flax straw, sent to his mill in Ireland for investigation.

MR. FRANK BARBOUR'S REPORT (EPITOMIZED)

In 1895, Mr. Frank Barbour, general manager of the Barbour Bros. Co., of Lisborn, Ireland, and of world wide reputation, visited Seattle on Puget Sound, where I had placed at the Chamber of Commerce samples of fine long fiber flax, grown by me in Whatcom County, State of Washington, which surprised and interested him so much, that he wrote to me, that if I would send him one ton of my Puget Sound flax straw to his establishment at Lisborn, Ireland, he would work it up, from the field to the finish, free of cost to me, an offer I gladly accepted, only requesting him to furnish full report and samples of the result.

Lot 1 consisted of 910 lbs. of flax straw, marked Puget Sound flax, two bushels of imported Riga seed sown per acre. This straw arrived in good condition and showed care in culture and handling, but was sown too thinly. It was also allowed to become too ripe before pulling, and was reported as being sown too late in the season. Had it been sown thicker, and pulled earlier, the fiber would have been much finer and of a much higher price. We divided this lot into two parts of 445 pounds each, and numbered them one and three.

NO. 1—IRISH SYSTEM

Once watered.

455 pounds was put in pond the 17th of June, and removed first of July, fourteen days in steep.

YIELD

455 lbs. dry straw yielded
60 lbs. of scutched flax.
7 lbs. scutched tow.
1 lb. tow combings or

13.1% scutched flax and 1.75%
of two combings.

NO. 3—BELGIAN SYSTEM

Watered twice.

455 lbs. was put in pond for first steep 17th of June and removed the 27th, ten days in steep; after drying was again put in steep 1st of July, and taken out the 9th of July, 8½ days in second steep.

YIELD

455 lbs. dry straw yielded
65½ lbs. of scutched flax.
7½ lbs. scutched tow.
1 lb. combings.
14.39% scutched flax and
1.81% tow combings.

MARKET VALUE.

The market value of this flax was £55, sterling per ton (\$275) per ton.
per lb.

Combings £18 sterling (90) per ton and the tow £13 sterling (\$65) per ton.

The market value of this flax was £69 sterling (\$345) per ton, equal to 15.4 cents per lb.; tow and combings same as No. 1, £18 sterling (\$90) per ton, and the tow £13 sterling.

HACKLING RESULTS.

60 lbs. flax yielded
6 lbs. dressed line worth
14½.
20 lbs. dressed line worth
17c.
8 lbs. dressed line worth 24c.
2 lbs breakings worth 10½c.
Total dressed line, 36 lbs.
36 lbs.\$6.40
Tow 1.13

7.53

65½ lbs. scutched flax yielded
1 lb. dressed line, worth
14½.
10 lbs. dressed line worth
17c.
28 lbs. dressed line worth
24c.
3 lbs. breakings 10½c.
Total line, 42 lbs.....\$ 8.89
Tow 1.33

\$10.02

REMARKS.

Dr. A. W. Thornton,
Whatcom County, Washington.

Dear Sir:—I beg to enclose you report upon American flax straw which you sent over to us to be treated.

We congratulate you, on the success of this experiment, which is far beyond our expectations, and we believe there is a great future before the flax growers in the west of America.

Yours faithfully,

FRANK BARBOUR.

The too thin seeding was in accordance with specific instructions from the Department of Agriculture. The delay in pulling was caused by difficulty in obtaining pullers, and owing to the too late sowing (by six weeks) and subsequent unusual dry and hot summer. The crop matured more rapidly than normal.

Comparing the single with the double retting system, the results favor largely the double ret, in not only increasing the yield of fiber, but increasing the percentages of the high priced qualities of line, and general money return for the crop.

I would here insert a paragraph from Mr. Barbour's letter of transmittal, "The flax is eminently adapted for thread making, or warp yarn spinning purposes. It is exceedingly strong and works well on the machines. If flax is grown and manipulated under proper conditions on Puget Sound, we are convinced that the cultivation of it would be of the greatest importance, and in a short time rival the great Belgian district of Courtrai."

How has the crop yielded and how did it pay? For some of figures in the following tables intended to solve the question I have taken from pamphlets now out of print. The first table gives the yield of retted flax fiber from, say 100 pounds of dried straw and the yield per cent of fiber from same after retting.

Flax Straw Before Retting	Flax Straw After Retting	Scutched Flax Fiber	Yield Per Cent of Fiber
No. 1—100 lbs.....	77.38 lbs.	19.04 lbs.	24.61 lbs.
No. 2—100 lbs.....	76.82 lbs.	18.84 lbs.	24.53 lbs.
No. 3—100 lbs.....	74.69 lbs.	16.66 lbs.	23.31 lbs.
No. 4—100 lbs.....	84.38 lbs.	17.97 lbs.	21.29 lbs.
No. 5—100 lbs.....	82.50 lbs.	16.72 lbs.	20.26 lbs.
No. 6—100 lbs.....	88.31 lbs.	15.56 lbs.	18.75 lbs.
Average—100 lbs.....	80.97 lbs.	16.49 lbs.	20.63 lbs.

GENERAL IDEA OR ORDINARY RESULTS.

An acre of fairly good flax is estimated to weigh on foot, or when fresh pulled, about five tons. In drying, it will probably lose about one-half, or a little more, say 55 per cent will be taken off the weight. Steeping will reduce it more in round numbers

about one fourth or twenty-five per cent, and if the yield of fiber is taken at the moderate figure of eighteen per cent, the loss in scutching would be eighty-two per cent. The following sketch traces the flax from the field to the market.

One statute acre, of green flax yields, say
 100 cwt., or five long tons; when dry-
 ing takes55%

Leaving45 Cwt.
 Seeding or rippling takes 20%..... 9

Leaving36 Cwt.
 Retting takes away 25%..... 9

Leaving27 Cwt.
 Breaking and scutching takes 82%.....22

Leaving 5% or (40 stone per acre)

A stone being fourteen pounds, and 1 cwt. being 112 lbs., brings the 40 stone product to 560 pounds of fiber per statute acre.

Coming to actual experience, figuring the cost of scutching at a flat rate of 25 cents per stone, would show that the yield is varied from 29 stones to 52 stones, or in American figures from 400 to 728 pounds per acre or before the war \$40 to \$111 per acre.

ROTATION OF CROPS

NO. 1	NO. 2	NO. 3
Oats	Potatoes	Clover and Grass
Turnips	Wheat	Grass
Wheat	Clover and Grass	Oats
Clover and Grass	Pasture	Potatoes & Turnips
Potatoes	Pasture	Wheat
Flax	Flax	Flax
No. 4	NO. 5	NO. 6
Root Crops	Barley	Potatoes
Barley	Clover and Grass	Barley laid down
Clover and Grass	Grazing	Grass
Wheat	Wheat	Pasture
Flax (half field)	Flax (half field)	Flax (half field)
NO. 7	NO. 8	NO. 9
Potatoes or Turnips	Turnips	Rape
Wheat	Barley	Wheat, Hay or Clover
Hay or Clover	Clover or hay	Clover
Grazing	Grazing	Rye
Oats	Oats	Peas and Oats
Flax	Flax	Flax

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